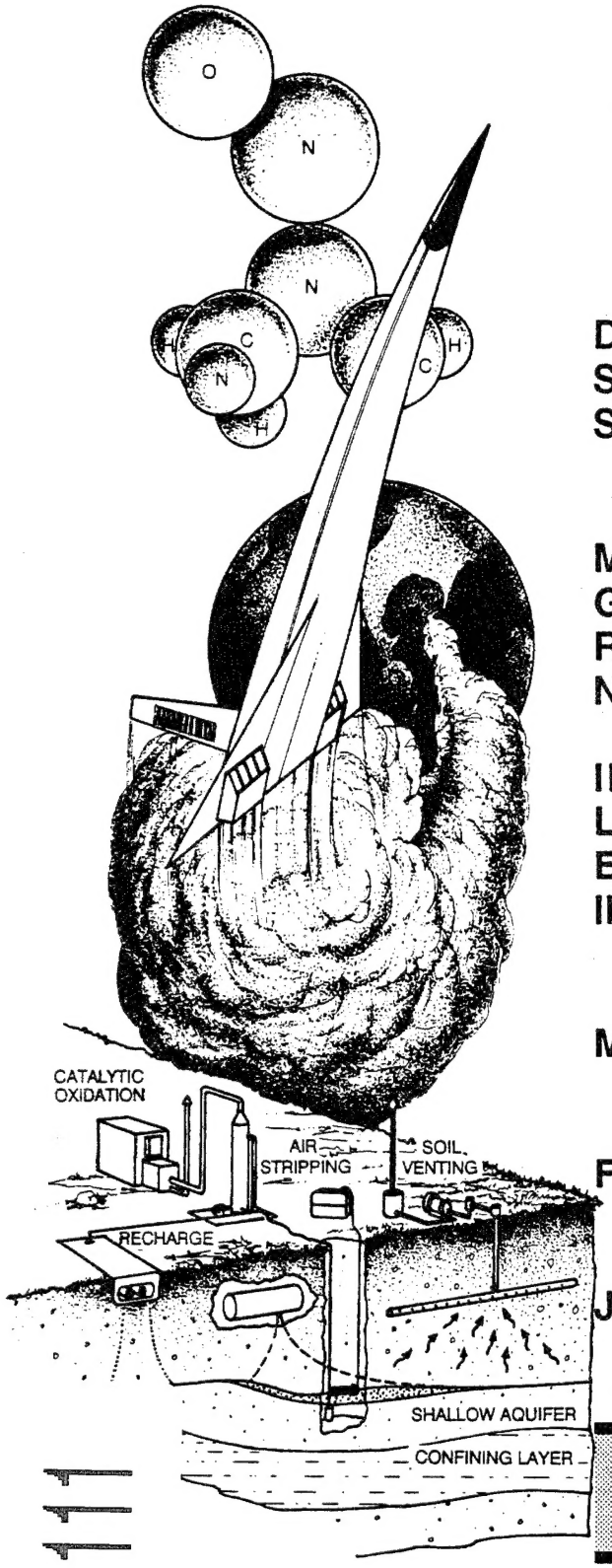

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DEMONSTRATION OF NONCYANIDE STRIPPERS TO REPLACE CYANIDE STRIPPERS, PART 2 OF 2

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13. ABSTRACT *(Maximum 200 words)*

This report is divided into parts. Part 1 consists of the front matter, text, and Appendixes A through F, pages 1-204. Part 2 consists of Appendixes G through K, pages 205-361. The objective of the work described in this report was to develop and demonstrate an improved means to replace cyanide containing metal stripping solution in the plating shops at the Air Logistics Centers. During the program, 35 commercial strippers, 3 Air Force process solutions, and a generic nickel stripper were tested. First, these strippers were evaluated on a laboratory scale. If a stripper proved worthwhile in the laboratory, it then was scaled up in a field test. The next step was to implement the most worthwhile products into the plating shop at Kelly AFB. Two strippers, B-9 Nickel Stripper and Rostrip 999-sp Electrolytic Silver stripper, have been successful and implemented into the plating shop at Kelly These strippers will effectively replace the cyanide stripping processes formerly used by the Air Force.

14. SUBJECT TERMS

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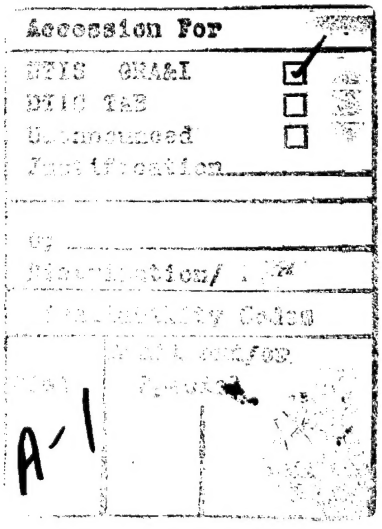
APPENDIX G

STRIPPING RATE DATA FOR IMPLEMENTED STRIPPERS AND ALTERNATIVE PLATE MATERIALS PERFORMED FOR THE PLATING SHOP AT KELLY AFB



Stripper	Test Date	Coupon Material	Coupon #	Density (g/cm3)	Unmasked Dimensions --------in inches-------- length	width	thick	hole	Suface Area (cm2)	Initial Mass (grams)	Final Mass (grams)	Change Mass (grams)	Total Time (hours)	Stripping Rate (mil/hr)	Average S.R. (mil/hr)
Implementation Monitoring @ KAFB, Bldg 301 Implementation Tank #127															
Niplex 100 Stripper Temp 143F pH 9.9 air agitation 7 months old															
Niplex	7-2-91	Ni-S	382	8.90	2.039	1.037	0.076	0.237	31.26	21.4730	21.3214	0.1516	2.0	1.07E-01	1.06E-01
Niplex	7-2-91	Ni-S	384	8.90	2.036	1.039	0.078	0.238	31.39	21.5224	21.3729	0.1495	2.0	1.05E-01	
Niplex	7-2-91	Ni-P""	39	8.90	2.025	1.014	0.071	0.237	30.14	18.0724	18.0622	0.0102	2.0	7.48E-03	8.08E-03
Niplex	7-2-91	Ni-P""	42	8.90	2.021	1.013	0.071	0.238	30.05	17.9236	17.9118	0.0118	2.0	8.68E-03	
Niplex	7-2-91	Ni-P K	28	8.90	2.020	1.005	0.072	0.234	29.90	17.9178	17.8154	0.1024	2.0	7.57E-02	6.53E-02
Niplex	7-2-91	Ni-P K	30	8.90	2.022	1.012	0.073	0.232	30.19	18.1234	18.0484	0.0750	2.0	5.50E-02	
Niplex	7-2-91	C4340	50	7.84	2.010	1.014	0.062	0.249	29.34	15.1978	15.1972	0.0006	24.0	4.28E-05	2.14E-05
Niplex	7-2-91	C4340	52	7.84	2.007	1.022	0.062	0.250	29.51	15.2738	15.2738	0.0000	24.0	0.00E+00	
Niplex	7-2-91	D6AC	22	8.20	2.010	0.989	0.079	0.250	29.67	18.6438	18.6437	0.0001	24.0	6.74E-06	6.76E-06
Niplex	7-2-91	D6AC	23	8.20	1.978	0.997	0.080	0.248	29.51	19.5979	19.5978	0.0001	24.0	6.78E-06	
Niplex 100 Stripper Temp 146F pH 10.3 air agitation 9 months old															
Niplex	9-5-91	Ni-S K	43	8.90	2.039	1.009	0.072	0.242	30.24	19.2508	19.2001	0.0507	2.0	3.71E-02	
Niplex	9-5-91	Ni-P K	47	8.90	2.015	1.057	0.081	0.243	31.73	19.8762	19.8582	0.0180	2.0	1.25E-02	
Niplex	9-5-91	D6AC	96	8.20	2.010	1.011	0.079	0.251	30.26	19.0674	19.0678	-0.0004	24.0	-2.64E-05	
Niplex	9-5-91	C4340	39	7.84	2.000	1.026	0.062	0.253	29.50	15.2617	15.2616	0.0001	24.0	7.09E-06	
Implementation Monitoring @ KAFB, Bldg 301 Implementation Tank #110															
CLEPO 204 Stripper Temp 130F pH 10.2 mechanical agitation 6 months old															
CLEPO	2-25-91	Ni-S	49	8.90	2.017	1.030	0.072	0.250	30.46	18.5918	16.5968	1.9950	4.0	7.24E-01	
CLEPO	2-25-91	Ni-P	50	8.90	2.005	1.020	0.070	0.250	29.90	16.7804	16.3280	0.4524	4.0	1.67E-01	
CLEPO	2-25-91	C4340	91	7.84	2.009	1.000	0.080	0.250	30.01	17.3652	17.3650	0.0002	24.0	1.39E-05	
CLEPO	2-25-91	D6AC	79	8.20	2.050	1.009	0.063	0.250	29.81	14.8723	14.8717	0.0006	24.0	4.03E-05	
CLEPO	2-25-91	3160	93	8.03	2.000	1.000	0.059	0.250	28.65	14.0395	14.0398	-0.0003	24.0	-2.14E-05	
CLEPO	2-25-91	410ss	75	7.70	2.009	1.002	0.068	0.250	29.35	14.2746	14.2746	0.0000	24.0	0.00E+00	
CLEPO	2-25-91	I-718	18	8.60	2.003	1.000	0.063	0.250	28.92	16.1909	16.1910	-0.0001	24.0	-6.60E-06	
CLEPO	2-25-91	HA-188	49	9.70	2.000	1.002	0.068	0.250	29.23	17.1106	17.1108	-0.0002	24.0	-1.16E-05	
CLEPO	2-25-91	17-4PH	55	7.80	2.000	1.000	0.062	0.250	28.82	15.2086	15.2090	-0.0004	24.0	-2.92E-05	
CLEPO 204 Stripper Temp 130F pH 10.0 mechanical agitation 10 months old															
CLEPO	6-6-91	S-Ni	49	8.90	2.012	1.022	0.067	0.242	29.91	16.5970	16.3664	0.2306	2.0	1.71E-01	
CLEPO	6-6-91	Ni-S	127	8.90	2.045	1.023	0.074	0.243	30.82	19.4738	19.3684	0.1054	2.0	7.56E-02	
CLEPO	6-6-91	Ni-P	50	8.90	2.004	1.017	0.067	0.243	29.66	16.3286	16.2533	0.0753	2.0	5.61E-02	
CLEPO	6-6-91	C4340	38	7.84	2.024	1.025	0.067	0.245	30.15	15.2910	15.2910	0.0000	24.0	0.00E+00	
CLEPO	6-6-91	D6AC	94	8.20	2.007	1.007	0.067	0.251	29.40	17.8383	17.8382	0.0001	24.0	6.81E-06	
CLEPO	6-6-91	3160	75	8.03	2.011	1.010	0.058	0.250	29.00	14.2746	14.2748	-0.0002	24.0	-1.41E-05	
CLEPO	6-6-91	410ss	93	7.70	2.009	1.012	0.058	0.254	29.01	14.0398	14.0398	0.0000	24.0	0.00E+00	
CLEPO	6-6-91	I-718	18	8.60	2.010	1.004	0.063	0.248	29.14	16.1910	16.1910	0.0000	24.0	0.00E+00	
CLEPO	6-6-91	HA-188	49	9.70	1.989	1.005	0.065	0.249	28.99	17.1108	17.1108	0.0000	24.0	0.00E+00	
CLEPO	6-6-91	17-4PH	55	7.80	1.998	1.003	0.063	0.250	28.93	15.2090	15.2090	0.0000	24.0	0.00E+00	

Stripper	Test Date	Coupon Material	Coupon #	Density (g/cm3)	Unmasked Dimensions --------in inches-------- length	width	thick	hole	Suface Area (cm2)	Initial Mass (grams)	Final Mass (grams)	Change Mass (grams)	Total Time (hours)	Stripping Rate (mil/hr)	Average S.R. (mil/hr)
CLEPO 204 Stripper	Temp 130F	pH 10.5	mechanical agitation	3 months old											
CLEPO	9-5-91	Ni-S K	41	8.90	2.023	1.050	0.073	0.246	31.16	19.2996	18.6031	0.6965	2.0	4.94E-01	
CLEPO	9-5-91	Ni-P K	48	8.90	2.013	1.008	0.072	0.243	29.84	17.6906	17.6025	0.0881	2.0	6.53E-02	
CLEPO	9-5-91	D6AC	97	8.20	2.030	1.009	0.083	0.251	30.72	20.7033	20.7030	0.0003	24.0	1.95E-05	
CLEPO	9-5-91	C4340	38	7.84	1.988	1.025	0.061	0.249	29.27	15.0279	15.0278	0.0001	24.0	7.15E-06	
									0.00						
Alternative Coatings															
Nickel-Boron and NiBron Testing															
CLEPO 204 Testing (used implemented stripper)			130F	pH 10.0	mechanical agitation										
CLEPO	7-23-91	Ni-B	A	8.90	2.563	1.125	0.013	0.403	36.40	5.3348	3.9944	1.3404	1.0	1.63E+00	
CLEPO	7-26-91	NIBRON	1	8.90	4.001	1.016	0.022	0.190	53.90	18.7228	17.7318	0.9910	1.0	8.13E-01	8.22E-01
CLEPO	7-26-91	NIBRON	2	8.90	4.000	1.032	0.027	0.193	55.13	19.0223	17.9858	1.0365	1.0	8.32E-01	
Metalx B-9 Testing (used implemented stripper)			142F	pH 10.0	air agitation										
B-9	7-23-91	Ni-B	B	8.90	2.563	1.344	0.013	0.400	43.70	6.0414	5.9831	0.0583	1.0	5.90E-02	
B-9	7-26-91	NIBRON	3	8.90	3.995	1.033	0.027	0.188	55.13	18.5778	18.4874	0.0904	1.0	7.25E-02	
Generic Stripper Testing (used longevity solution)			128-130F	pH 10.2	mechanical agitation										
Generic	7-29-91	Ni-B	N/A	8.90	2.678	1.261	0.013	0.400	42.83	5.4101	4.0182	1.3919	1.0	1.44E+00	**
Generic	7-29-91	NIBRON	N/A	8.90	4.000	1.015	0.037	0.199	55.12	19.2099	18.1954	1.0145	1.0	8.14E-01	
** Denotes minimum stripping rate since all coating was removed during the test															
Titanium and Chromium Tests in Generic Stripper			Temp 130F	pH 10.3	mechanical agitation										
Generic	8-14-91	Ti	N/A	4.50	1.012	0.563	0.025	0.000	8.36	1.8067	1.8068	-0.0001	24.0	-4.36E-05	-4.46E-05
Generic	8-14-91	Ti	N/A	4.50	0.995	0.545	0.025	0.000	8.00	1.7232	1.7233	-0.0001	24.0	-4.56E-05	
Generic	8-14-91	Cr	33	7.20	2.057	1.040	0.075	0.243	31.51	19.5751	19.5759	-0.0008	24.0	-5.78E-05	-5.06E-05
Generic	8-14-91	Cr	52	7.20	2.055	1.041	0.075	0.244	31.51	19.4436	19.4442	-0.0006	24.0	-4.34E-05	
Wax Tests in Generic Stripper			Temp 130F	pH 10.2	mechanical agitation										
Generic	9-24-91	Wax	N/A		inital OD 1.2048"		final OD 1.2045"			11.1350	11.0730	0.0620	19.0		
Generic	9-24-91	Wax	N/A		inital OD 1.5030"		final OD 1.4996"			13.0822	13.0235	0.0587	19.0		
Enthone, Inc. Enplate Ni-425 Stripping Rate Tests															
Generic Stripper	Temp 130F	pH 10.2	mechanical agitation												
Generic	9-4-91	Ni-425	382	8.90	4.006	3.000	0.013	0.245	155.86	20.2026	20.1947	0.0079	2.3	9.97E-04	1.07E-03
Generic	9-4-91	Ni-425	384	8.90	4.006	3.078	0.013	0.124	160.36	20.8754	20.8661	0.0093	2.3	1.14E-03	
Generic	9-4-91	Ni-425	1	8.90	4.006	3.000	0.013	0.245	155.86	20.2026	20.1947	0.0079	2.0	1.12E-03	1.20E-03
Generic	9-4-91	Ni-425	2	8.90	4.006	3.078	0.013	0.124	160.36	20.8754	20.8661	0.0093	2.0	1.28E-03	
Generic	9-4-91	Ni-425	3	8.90	4.006	3.000	0.013	0.245	155.86	20.1947	20.1494	0.0453	24.0	5.36E-04	5.43E-04
Generic	9-4-91	Ni-425	4	8.90	4.006	3.078	0.013	0.124	160.36	20.8661	20.8183	0.0478	24.0	5.49E-04	

Stripper	Test Date	Coupon Material	Coupon #	Density (g/cm3)	Unmasked Dimensions --------in inches-------- length	width	thick	hole	Suface Area (cm2)	Initial Mass (grams)	Final Mass (grams)	Change Mass (grams)	Total Time (hours)	Stripping Rate (mil/hr)	Average S.R. (mil/hr)
Metalx B-9 Stripper Temp 144F pH 10.1 air agitation															
B-9	9-4-91	Ni-425	39	8.90	4.020	2.988	0.013	0.237	155.82	20.3360	20.3220	0.0140	2.3	1.77E-03	
B-9	9-4-91	Ni-425	5	8.90	4.020	2.988	0.013	0.237	155.82	20.3360	20.3220	0.0140	2.0	1.99E-03	
B-9	9-4-91	Ni-425	6	8.90	4.020	2.988	0.013	0.237	155.82	20.3220	20.1746	0.1474	24.0	1.74E-03	
Niplex 100 Stripper Temp 146F pH 10.3 air agitation															
Niplex	9-4-91	Ni-425	28	8.90	4.007	3.022	0.013	0.116	157.51	20.7756	20.7700	0.0056	2.3	6.99E-04	
Niplex	9-4-91	Ni-425	7	8.90	4.007	3.022	0.013	0.116	157.51	20.7756	20.7700	0.0056	2.0	7.86E-04	
Niplex	9-4-91	Ni-425	8	8.90	4.007	3.022	0.013	0.116	157.51	20.7700	20.7274	0.0426	24.0	4.98E-04	
CLEPO 204 Stripper Temp 136F pH 10.5 mechanical agitation															
CLEPO	9-4-91	Ni-425	50	7.84	4.006	3.040	0.013	0.134	158.36	20.7876	20.7814	0.0062	2.3	8.74E-04	
CLEPO	9-4-91	Ni-425	9	8.90	4.006	3.040	0.013	0.134	158.36	20.7876	20.7814	0.0062	2.0	8.66E-04	
CLEPO	9-4-91	Ni-425	10	8.90	4.006	3.040	0.013	0.134	158.36	20.7814	20.7438	0.0376	24.0	4.38E-04	
AF C-106 Process Temp 130F pH 12.8 magnetic stirring															
C106	9-11-91	Ni-425	N/A	8.90	4.005	3.053	0.013	0.119	159.04	20.3560	20.3333	0.0227	2.0	3.16E-03	4.52E-03
C106	9-11-91	Ni-425	N/A	8.90	4.005	2.877	0.013	0.245	149.45	19.2870	19.2472	0.0398	2.0	5.89E-03	
Witco, Corp. Niklad* 797 Stripping Rate Tests															
Generic Stripper Temp 133F pH 10.2 mechanical agitation															
Generic	9-18-91	Nik-797	A	8.90	3.997	3.003	0.017	0.123	156.51	26.0321	23.3364	2.6957	1.0	7.62E-01	7.52E-01
Generic	9-18-91	Nik-797	B	8.90	3.998	3.004	0.017	0.130	156.58	26.0921	23.4666	2.6255	1.0	7.42E-01	
CLEPO 204 Stripper Temp 136F pH 10.2 mechanical agitation															
CLEPO	9-18-91	Nik-797	C	8.90	3.997	3.004	0.016	0.126	156.53	25.8560	25.4134	0.4426	1.0	1.25E-01	
Metalx B-9 Stripper Temp 142F pH 10.0 air agitation															
B-9	9-18-91	Nik-797	M	8.90	3.997	3.004	0.017	0.131	156.54	26.0737	24.6565	1.4172	1.0	4.00E-01	
Niplex 100 Stripper Temp 146F pH 10.0 air agitation															
Niplex	9-18-91	Nik-797	N	8.90	3.996	3.004	0.017	0.135	156.49	26.0320	25.6428	0.3892	1.0	1.10E-01	
MetalX B-9 Regenerants Testing 130F 2L volume magnetic agitation Regenerated with 5% Reservol-P (Na m-NBS) pH 10.05															
B-9 Regen	7-26-91	Ni-S	424	8.90	2.038	1.041	0.076	0.236	31.36	21.2035	20.8769	0.3266	2.0	2.30E-01	
B-9 Regen	7-26-91	Ni-P K	4	8.90	2.014	1.010	0.086	0.243	30.74	21.7366	21.4786	0.2580	2.0	1.86E-01	1.78E-01
B-9 Regen	7-26-91	Ni-P K	5	8.90	2.008	0.997	0.093	0.241	30.73	22.8118	22.5747	0.2371	2.0	1.71E-01	
B-9 Regen	7-26-91	C4340	69	7.84	2.008	1.028	0.062	0.253	29.66	15.4223	15.4216	0.0007	24.0	4.94E-05	
B-9 Regen	7-26-91	D6AC	28	8.20	2.001	1.003	0.077	0.249	29.81	19.0309	19.0302	0.0007	24.0	4.70E-05	

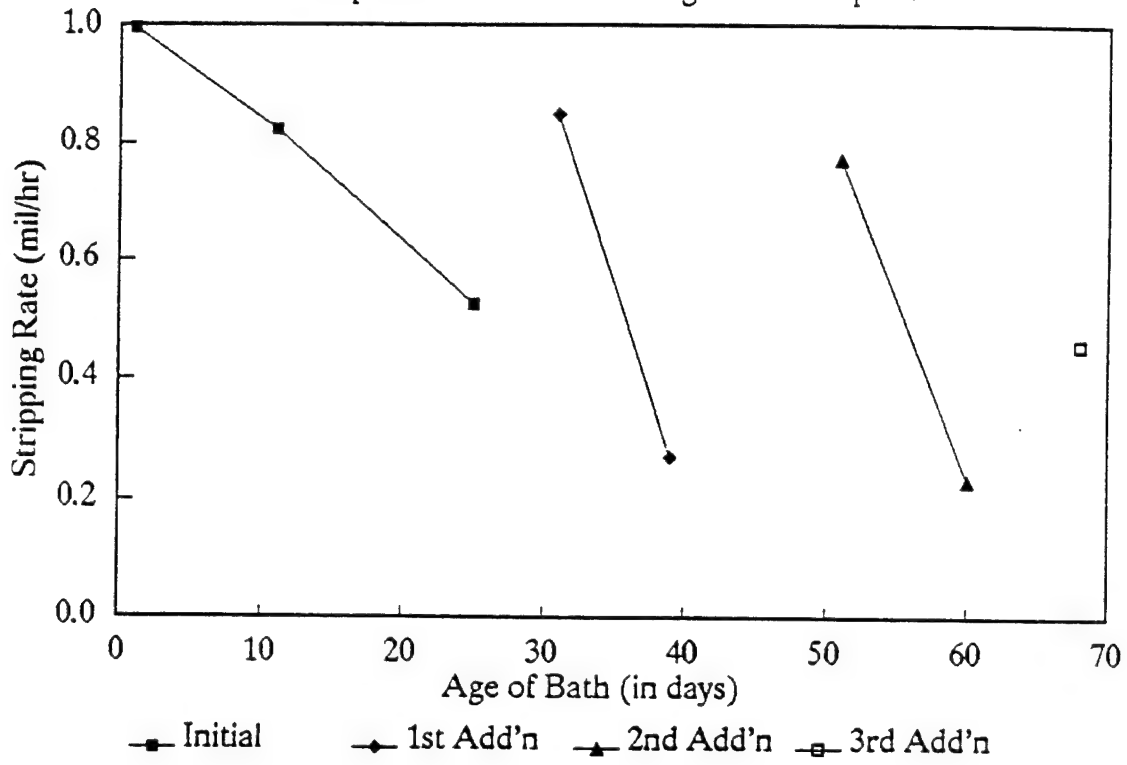
Stripper	Test Date	Coupon Material	Coupon #	Density (g/cm3)	Unmasked Dimensions --------in inches-------- length	width	thick	hole	Suface Area (cm2)	Initial Mass (grams)	Final Mass (grams)	Change Mass (grams)	Total Time (hours)	Stripping Rate (mil/hr)	Average S.R. (mil/hr)
Regenerated with 5% Ethylenediamine pH 11.10															
B-9 Regen	7-26-91	Ni-S	432	8.90	2.044	1.039	0.075	0.238	31.32	21.0603	21.0495	0.0108	2.0	7.63E-03	
B-9 Regen	7-26-91	Ni-P K	6	8.90	2.024	1.002	0.086	0.241	30.67	21.2909	21.2760	0.0149	2.0	1.07E-02	1.11E-02
B-9 Regen	7-26-91	Ni-P K	7	8.90	2.027	0.997	0.085	0.243	30.51	20.8588	20.8431	0.0157	2.0	1.14E-02	
B-9 Regen	7-26-91	C4340	70	7.84	2.008	1.025	0.062	0.254	29.58	15.2420	15.1478	0.0942	24.0	6.66E-03	
B-9 Regen	7-26-91	D6AC	29	8.20	2.018	0.997	0.083	0.248	30.24	20.3979	20.3286	0.0693	24.0	4.58E-03	
Regenerated with 5.46% MetalX B-9 pH 10.0															
B-9 Regen	7-26-91	Ni-S	434	8.90	2.055	1.065	0.080	0.235	32.51	23.7064	23.3898	0.3166	2.0	2.15E-01	
B-9 Regen	7-26-91	Ni-P K	8	8.90	2.010	0.960	0.072	0.241	28.52	16.7460	16.5634	0.1826	2.0	1.42E-01	1.43E-01
B-9 Regen	7-26-91	Ni-P K	9	8.90	1.991	1.008	0.080	0.243	30.01	19.7588	19.5624	0.1964	2.0	1.45E-01	
B-9 Regen	7-26-91	C4340	71	7.84	2.008	1.030	0.062	0.253	29.72	15.4565	15.4556	0.0009	24.0	6.34E-05	
B-9 Regen	7-26-91	D6AC	30	8.20	2.013	0.960	0.081	0.247	29.06	19.0781	19.0755	0.0026	24.0	1.79E-04	

APPENDIX H

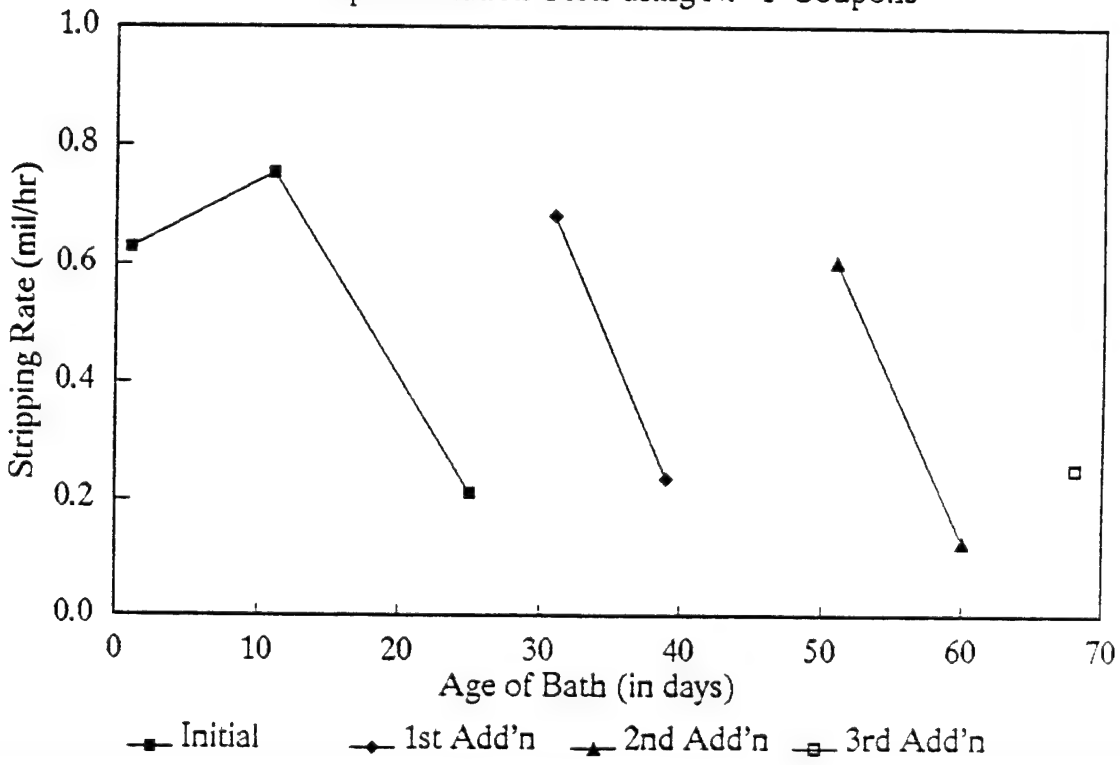
GRAPHICAL PRESENTATION OF THE IMPLEMENTATION AND FIELD TEST DATA FROM PHASE I OF THE DNCYS PROGRAM (FY-91)

Metalx Inc.'s B–9 Nickel Stripper

Implementation Tests using Ni–S Coupons

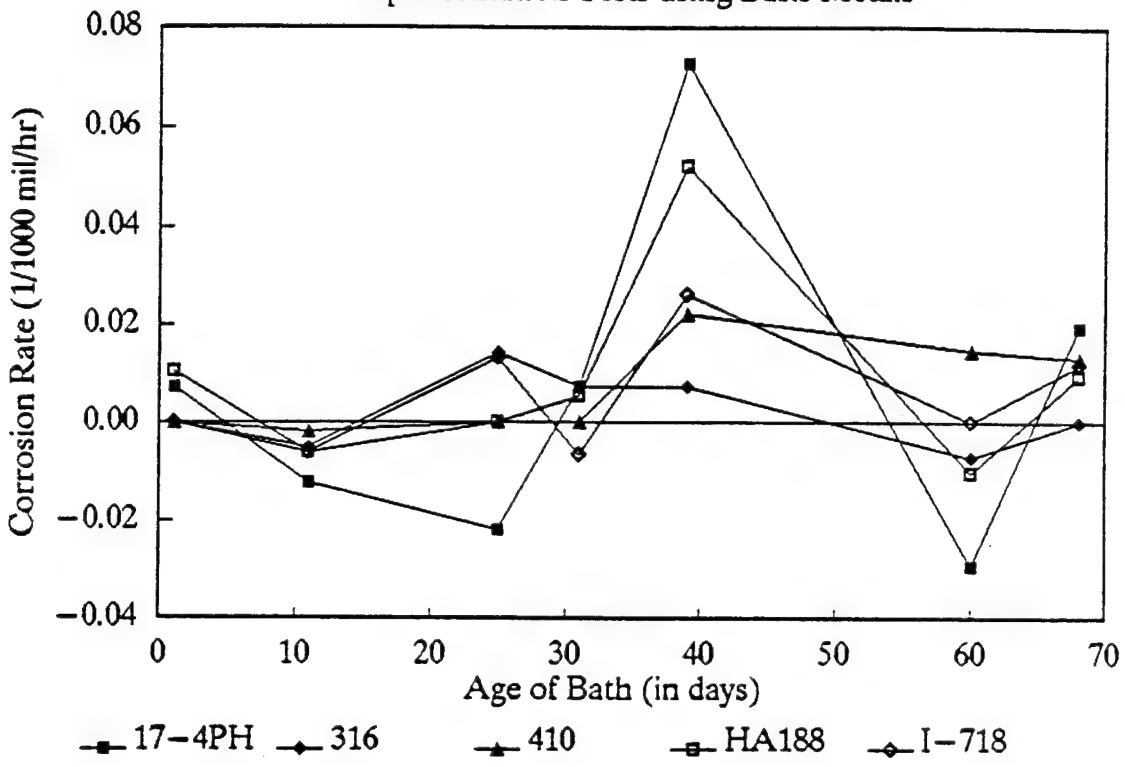


Implementation Tests using Ni–P Coupons

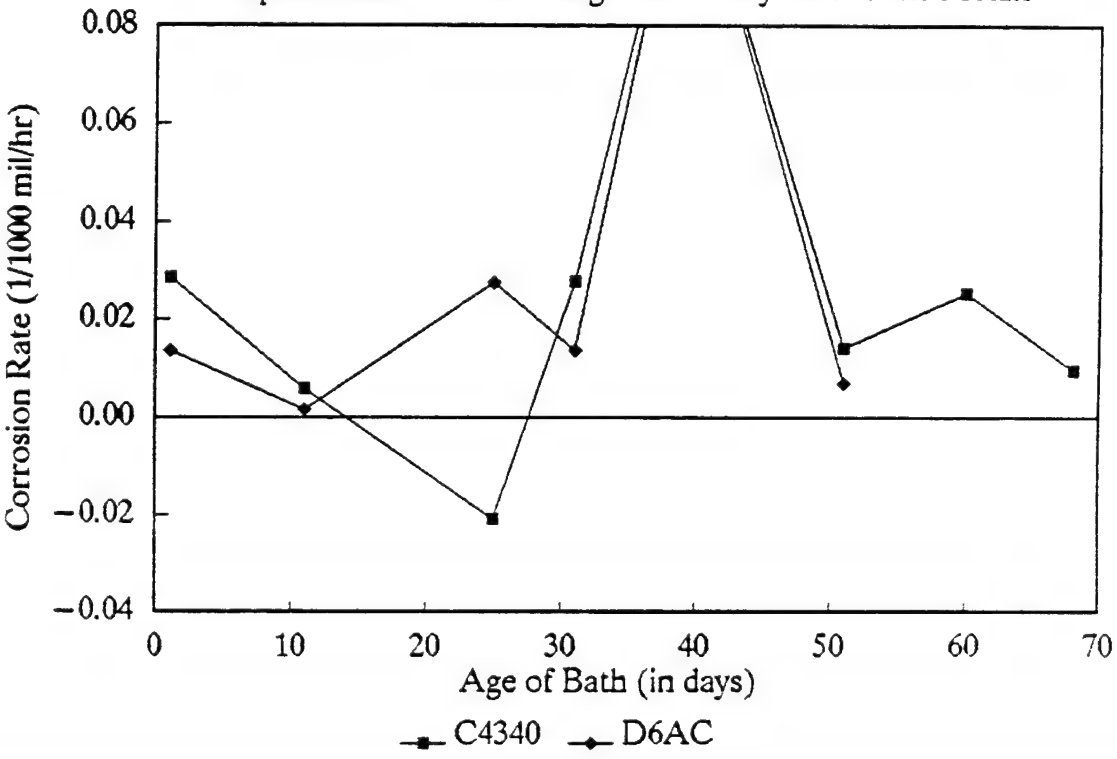


Metalx Inc.'s B–9 Nickel Stripper

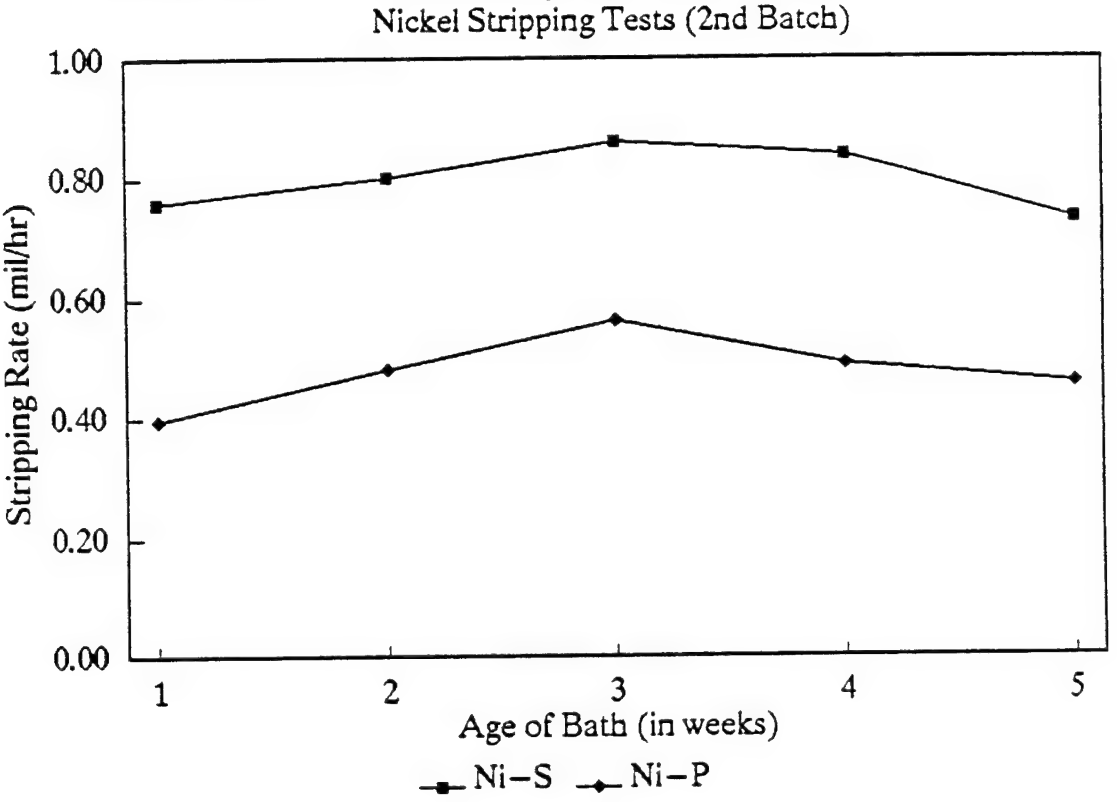
Implementation Tests using Basis Metals

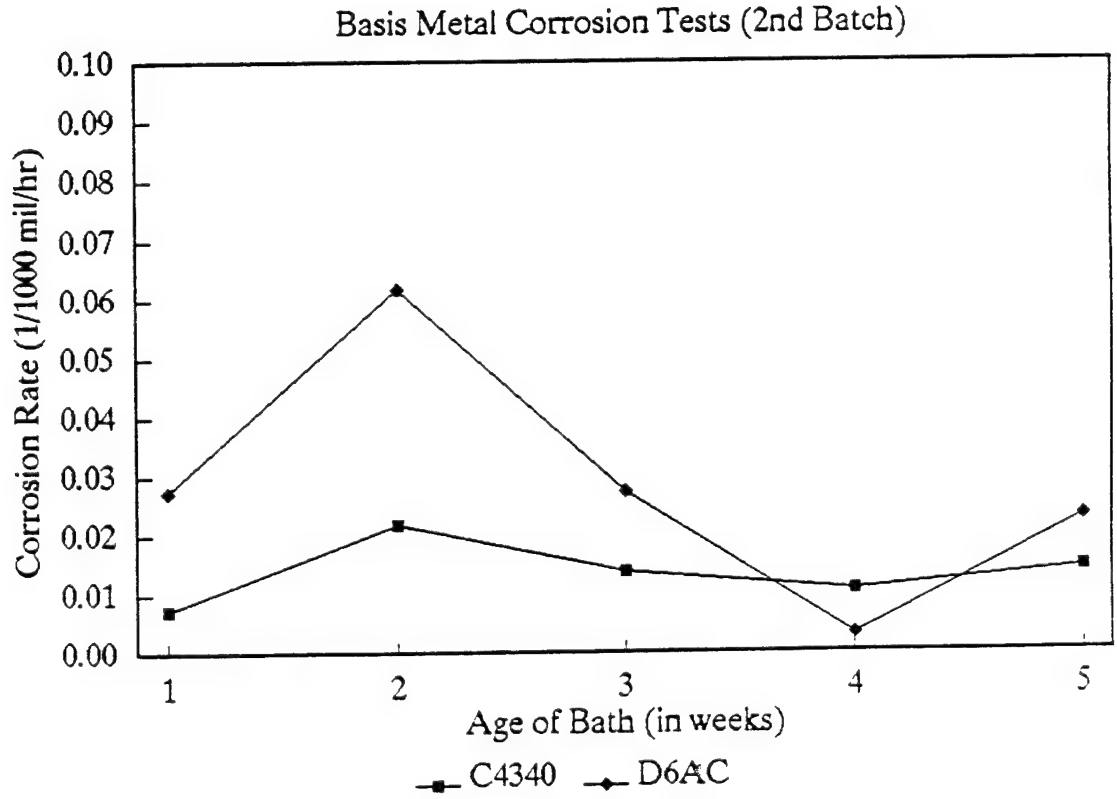


Implementation Tests using Low–Alloy Steel Basis Metals



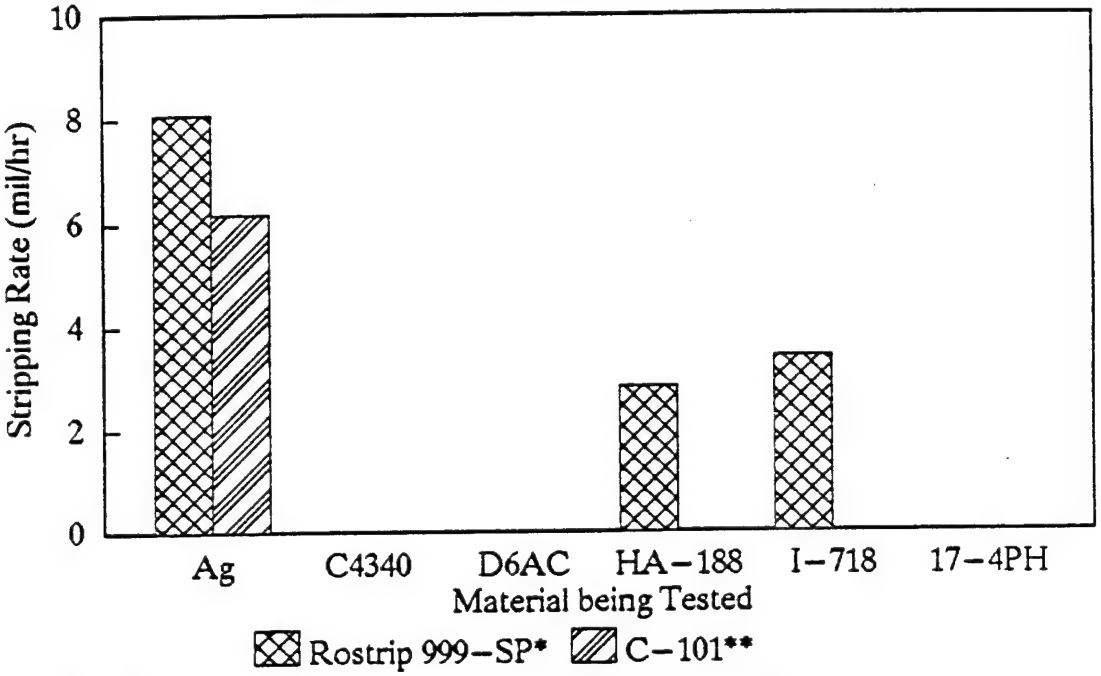
Metalx B-9 Implementation Tests





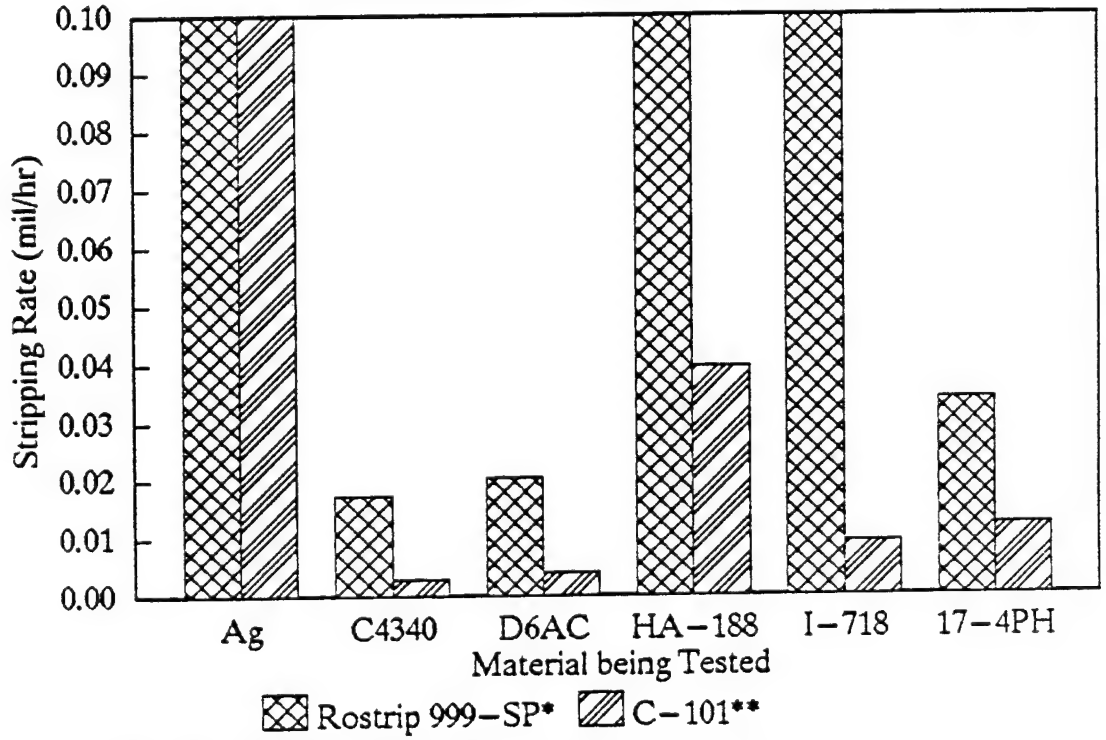
Comparison Testing of Silver Strippers

Rostrip 999–SP vs AFB C–101 Process



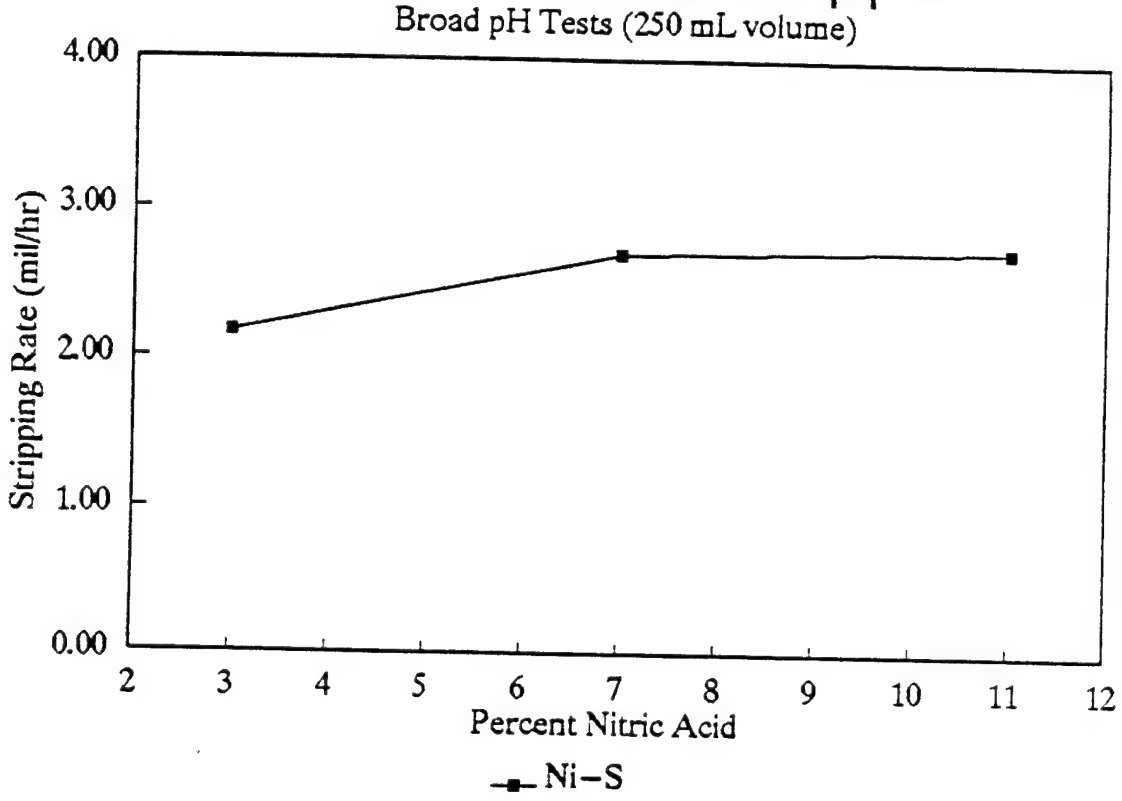
* Conditions: ambient temp., pH 12.0, 3.8 Volt, 6.0 Amp
**Conditions: ambient temp., pH 13.0, 4.0 Volt, 6.0 Amp

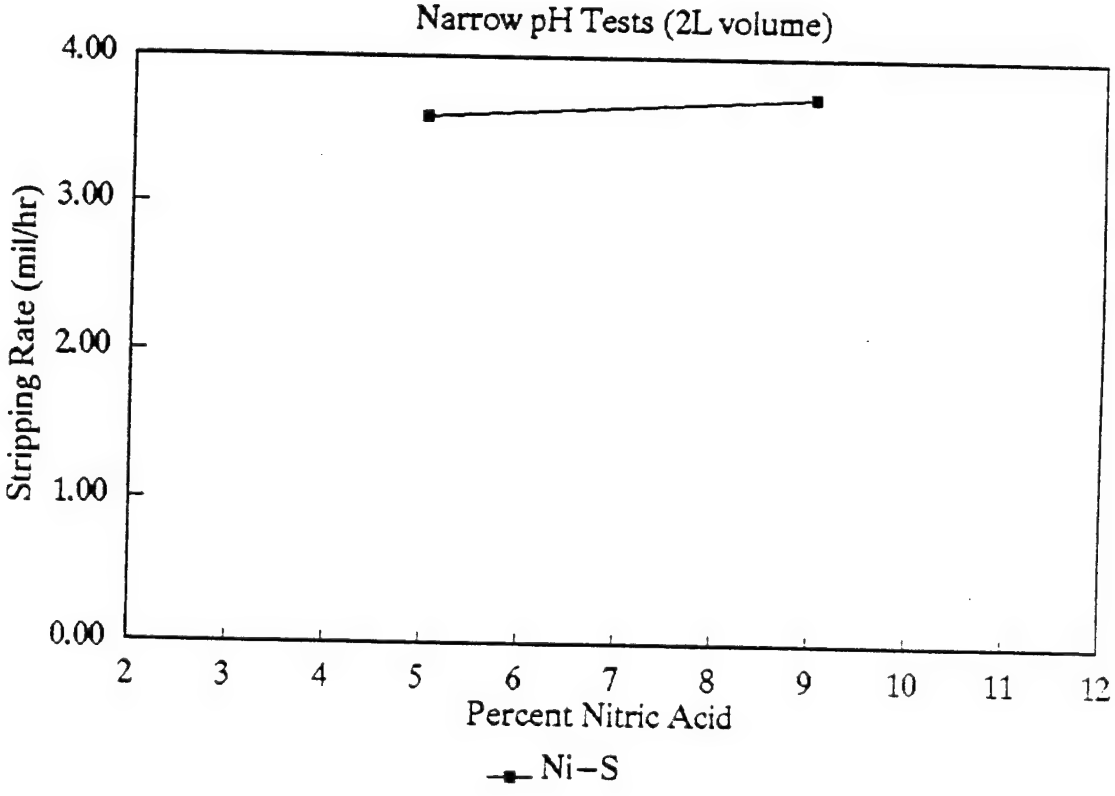
Scale expanded to enhance baseline values



* Conditions: ambient temp., pH 12.0, 3.8 Volt, 6.0 Amp
**Conditions: ambient temp., pH 13.0, 4.0 Volt, 6.0 Amp

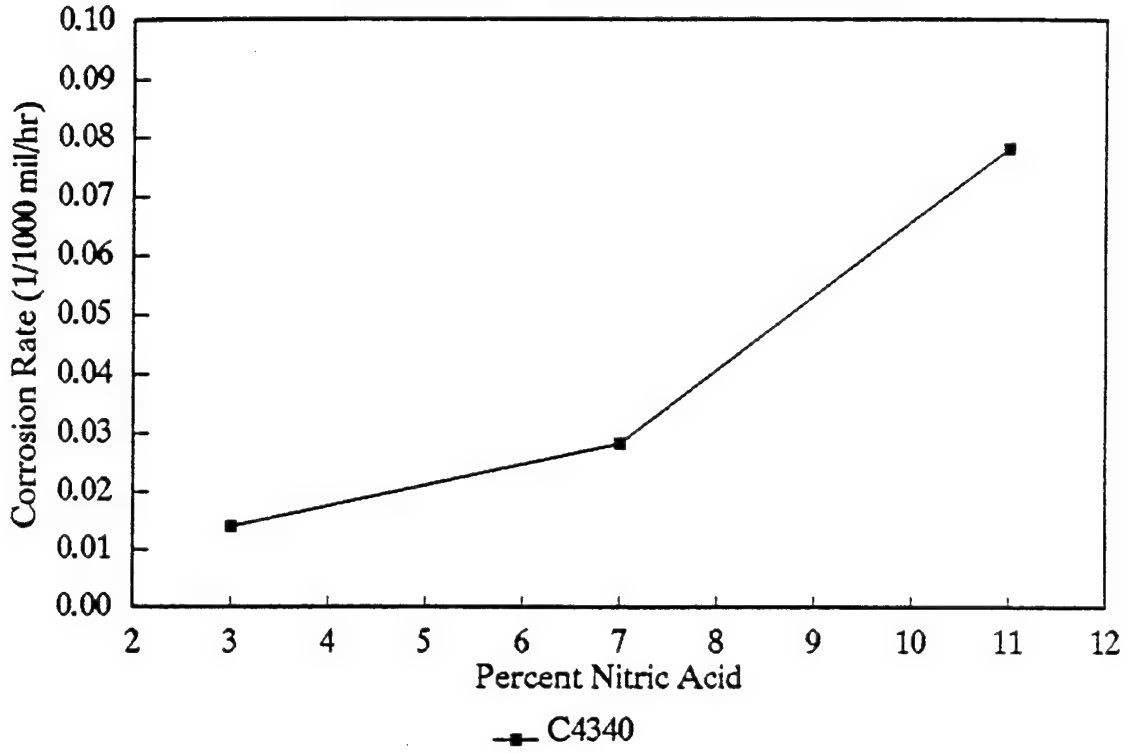
Generic Nickel Stripper



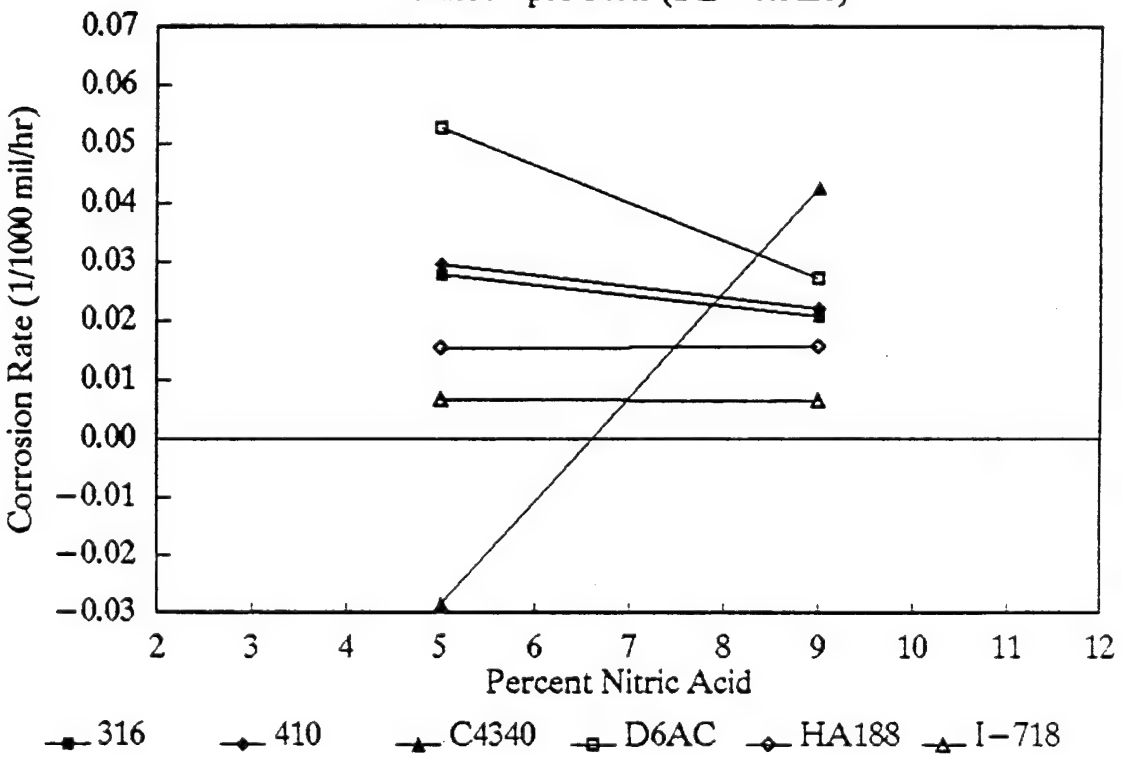


Generic Nickel Stripper

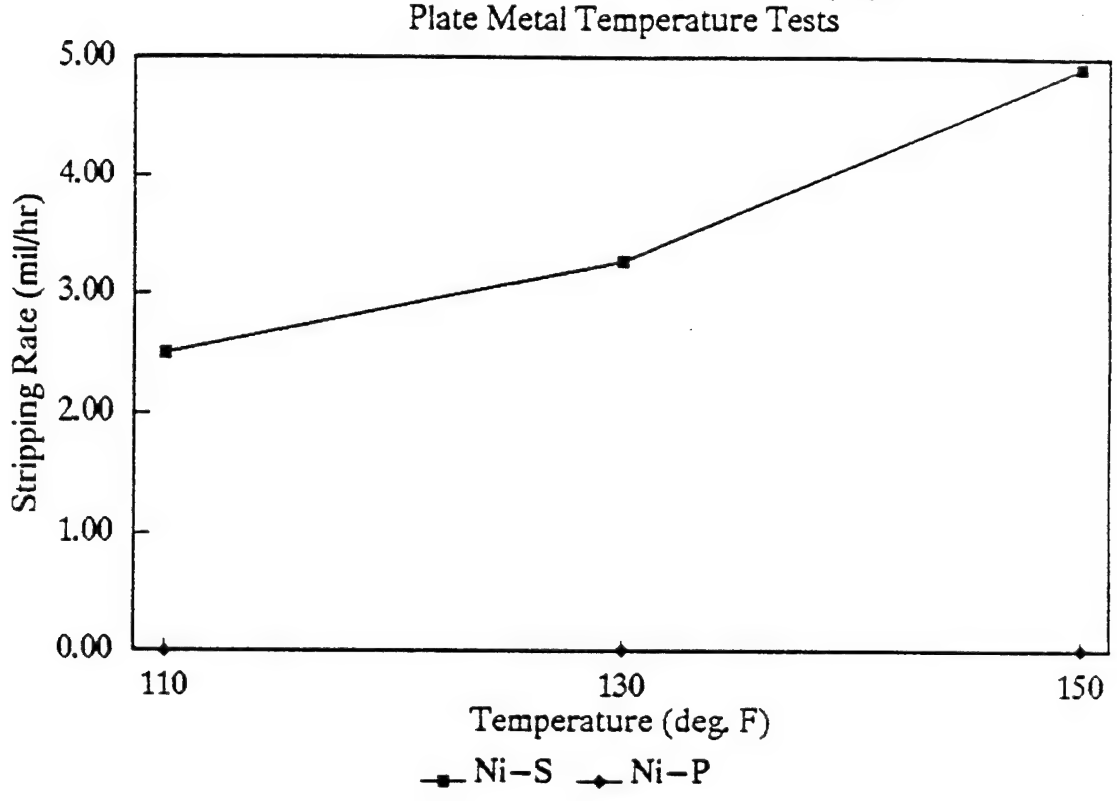
Broad pH Tests (250 mL Volume)

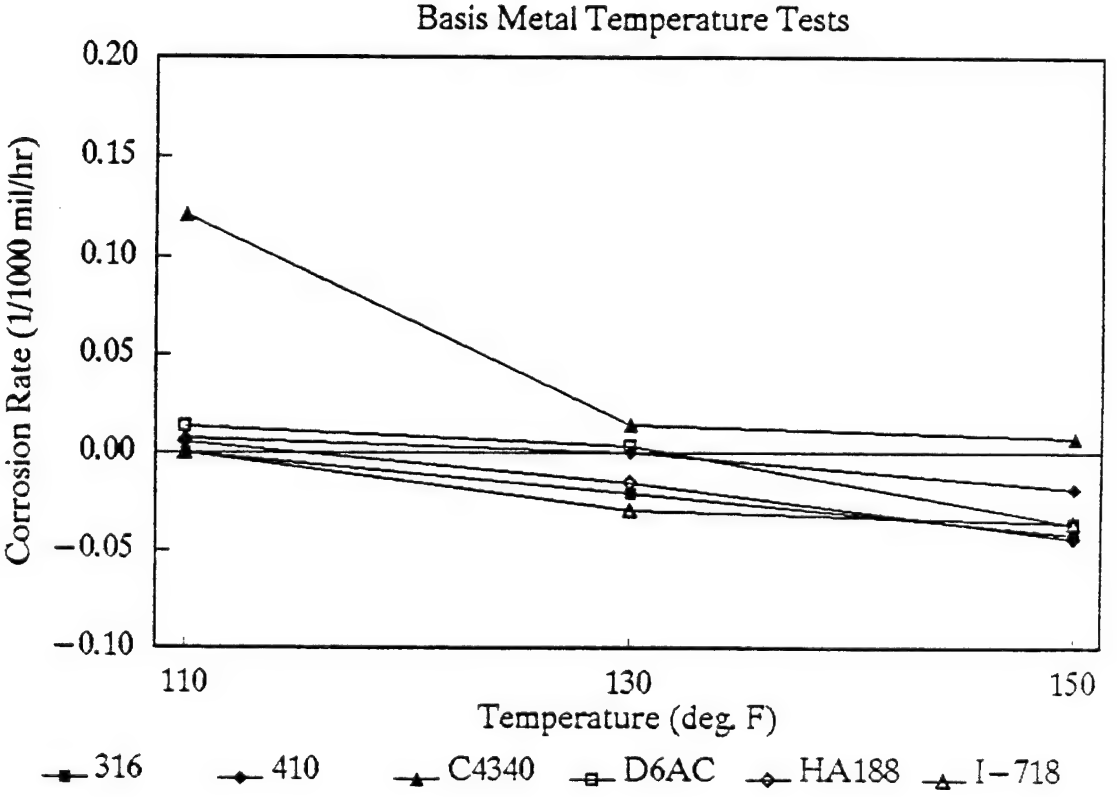


Narrow pH Tests (2 L Volume)



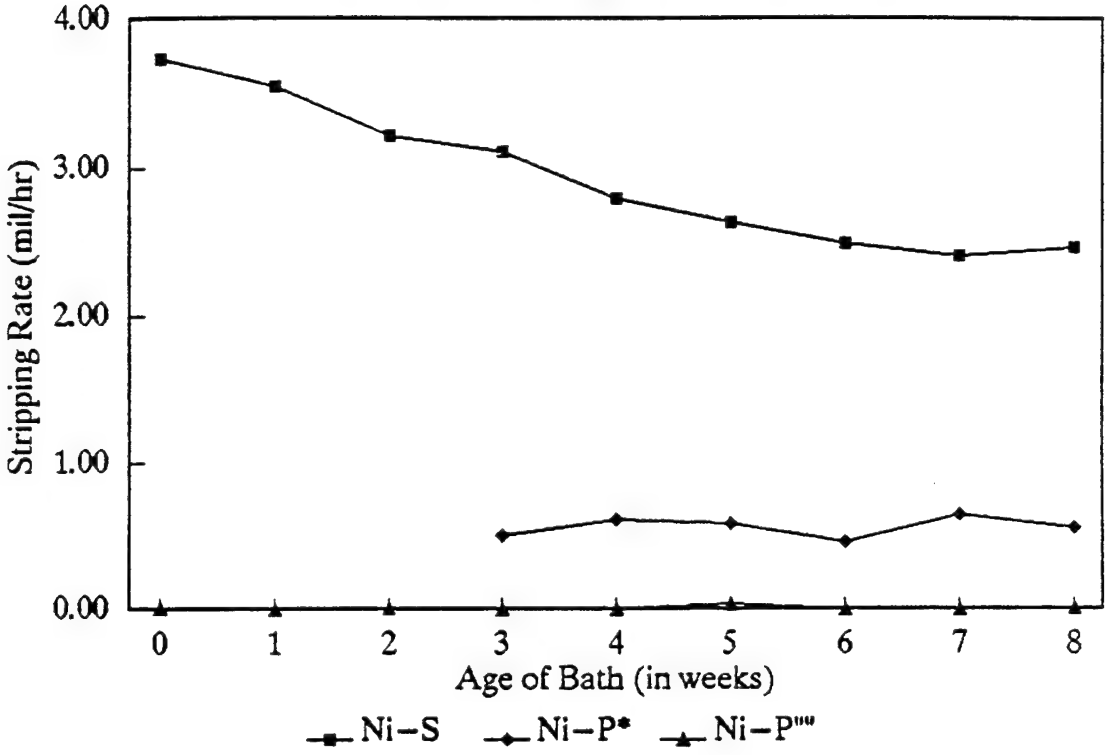
Generic Nickel Stripper



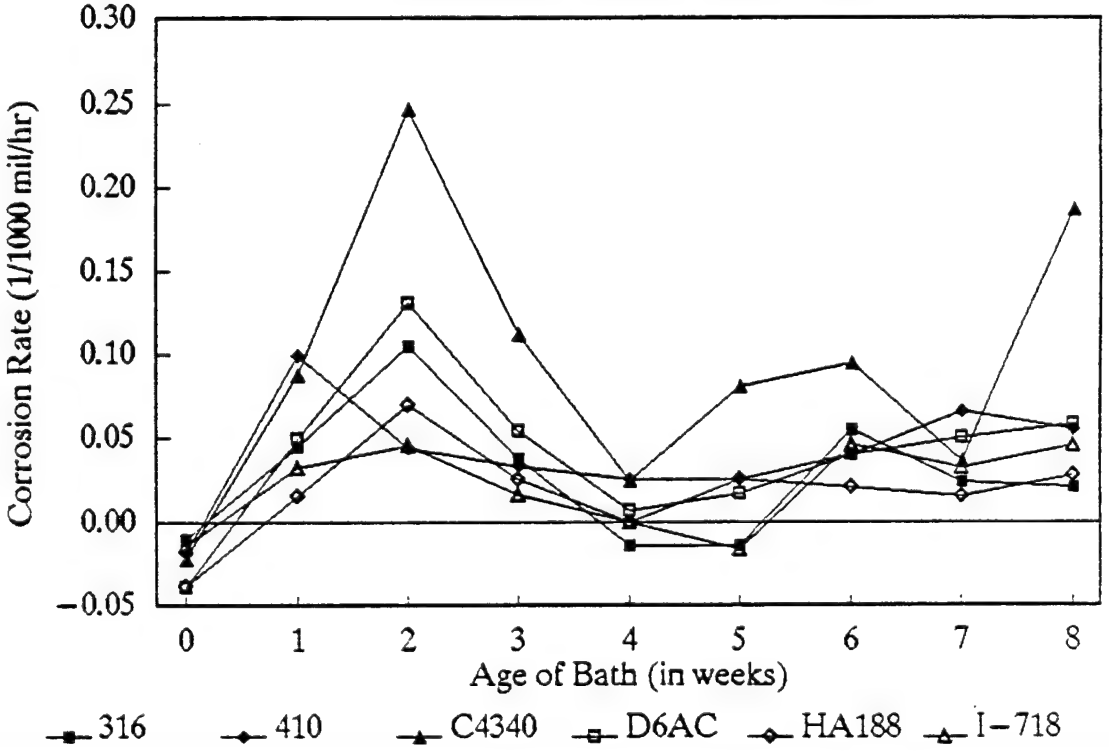


Generic Nickel Stripper

Plate Metal Longevity Tests at 130F

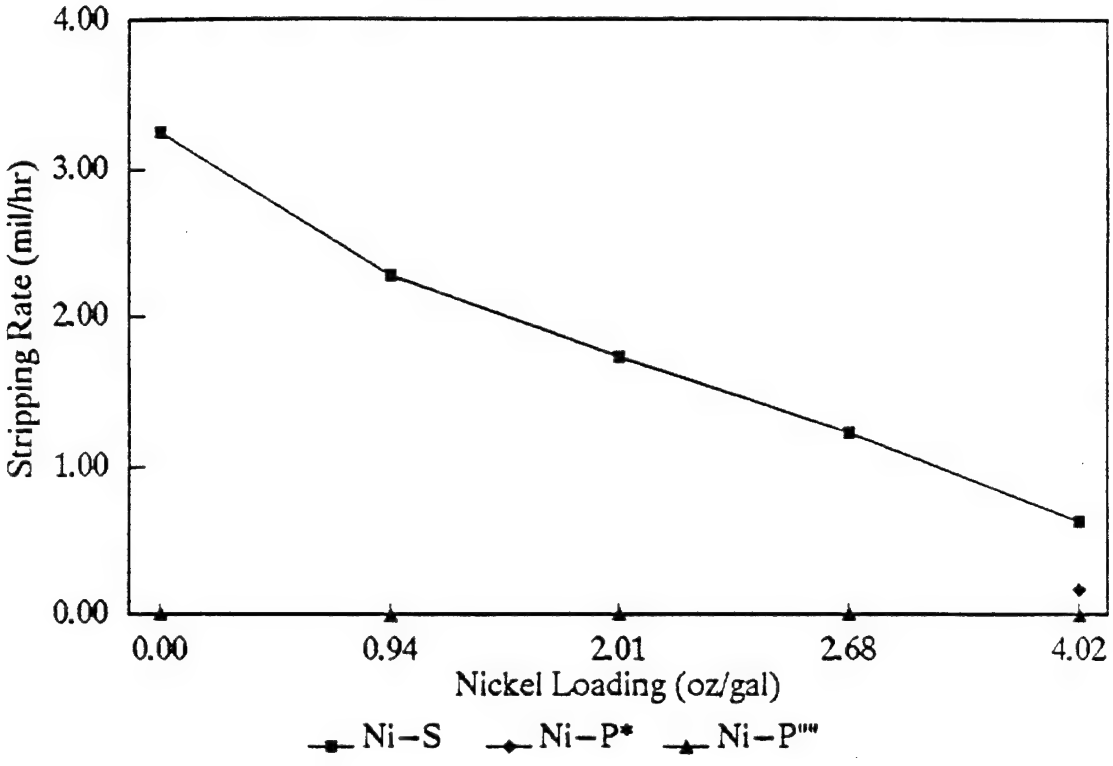


Basis Metal Longevity Tests at 130F

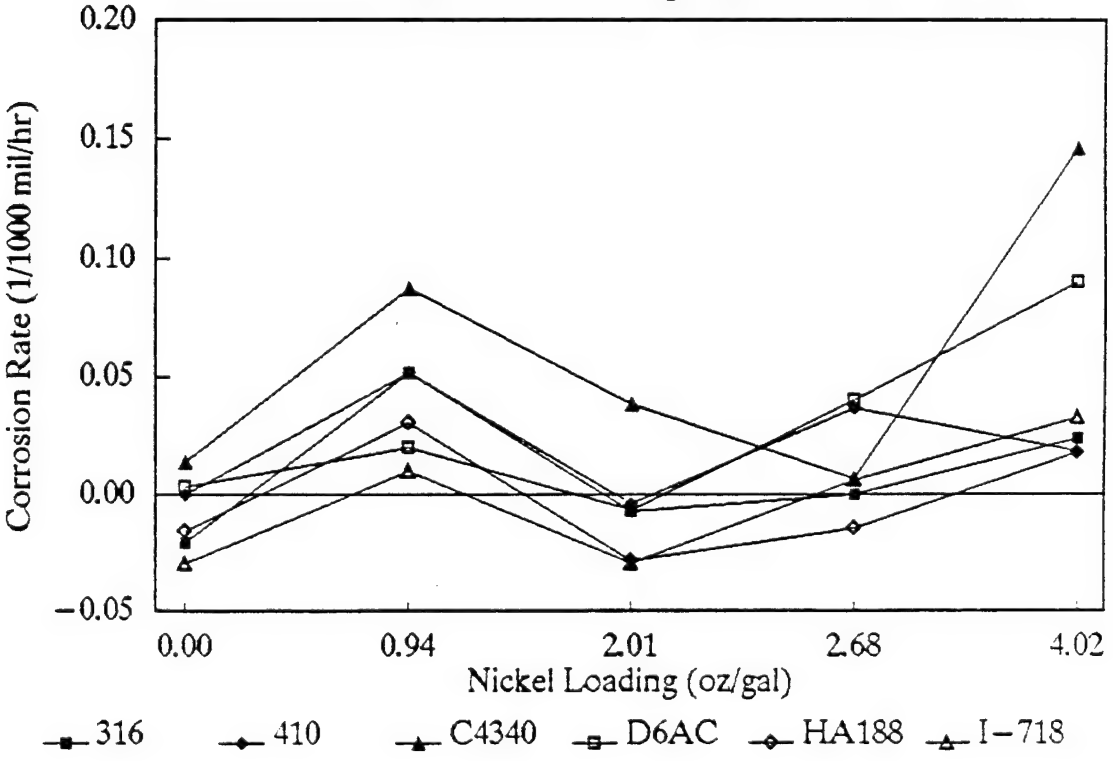


Generic Nickel Stripper

Plate Metal Loading Tests at 130F

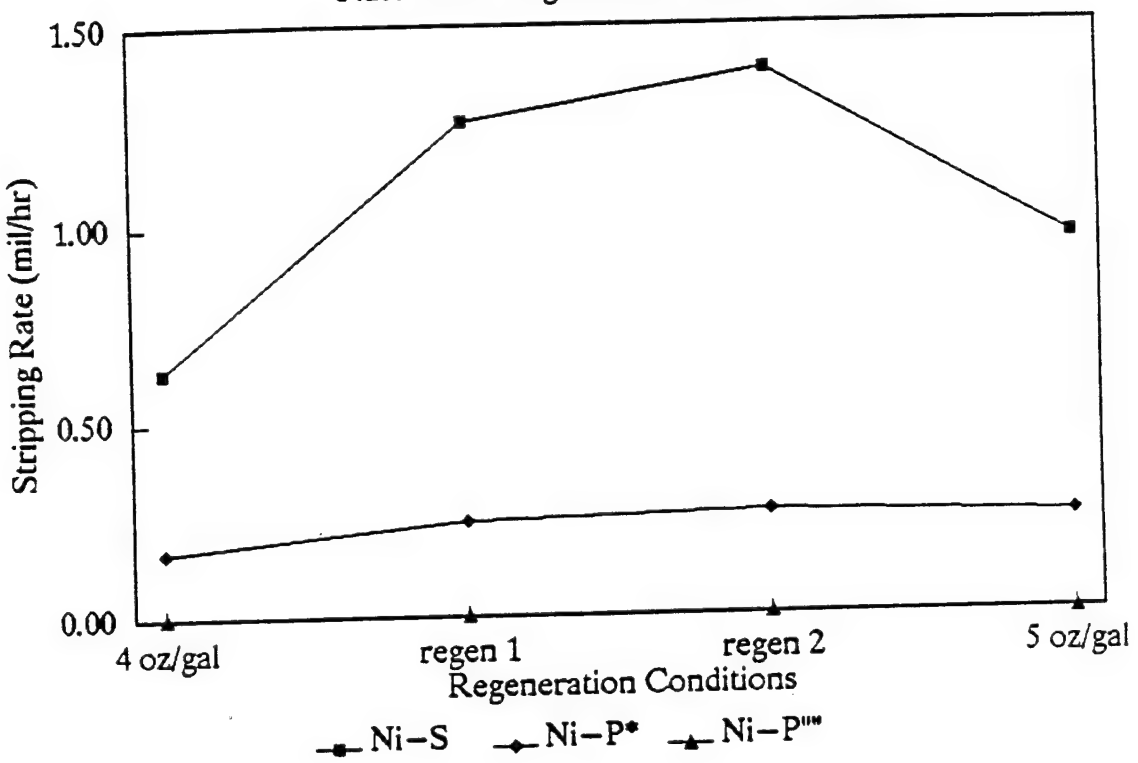


Basis Metal Loading Tests at 130F

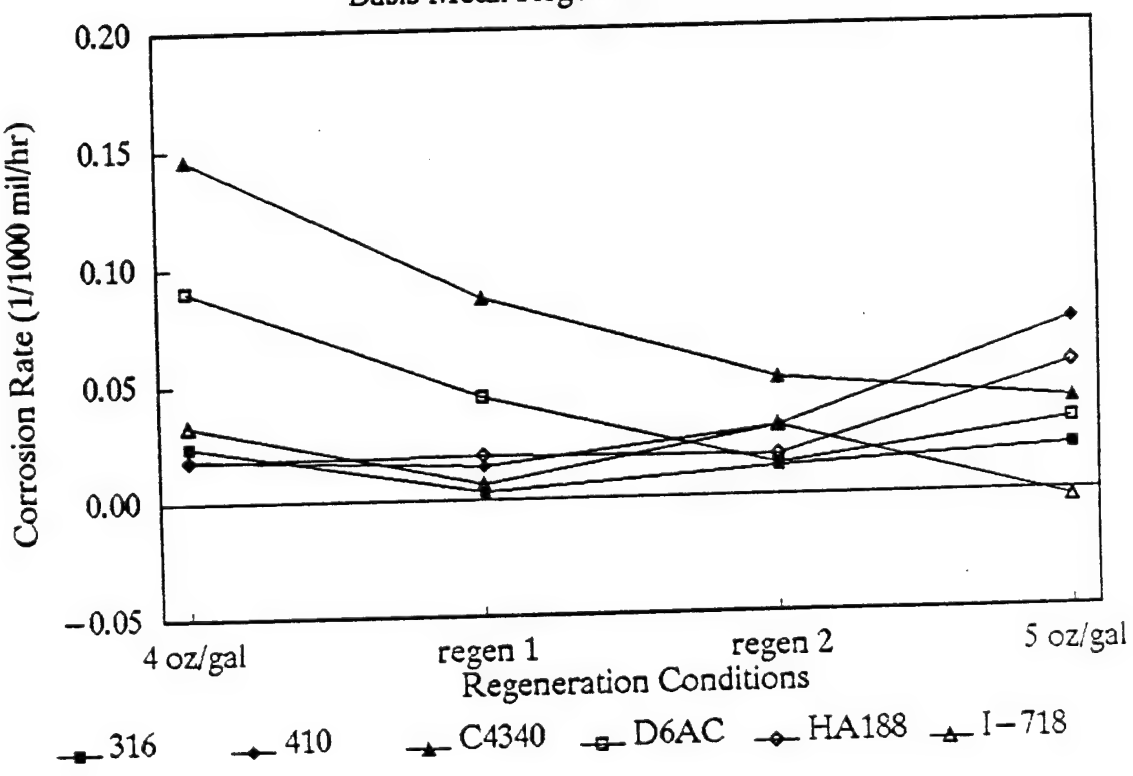


Generic Nickel Stripper

Plate Metal Regeneration Tests at 130F

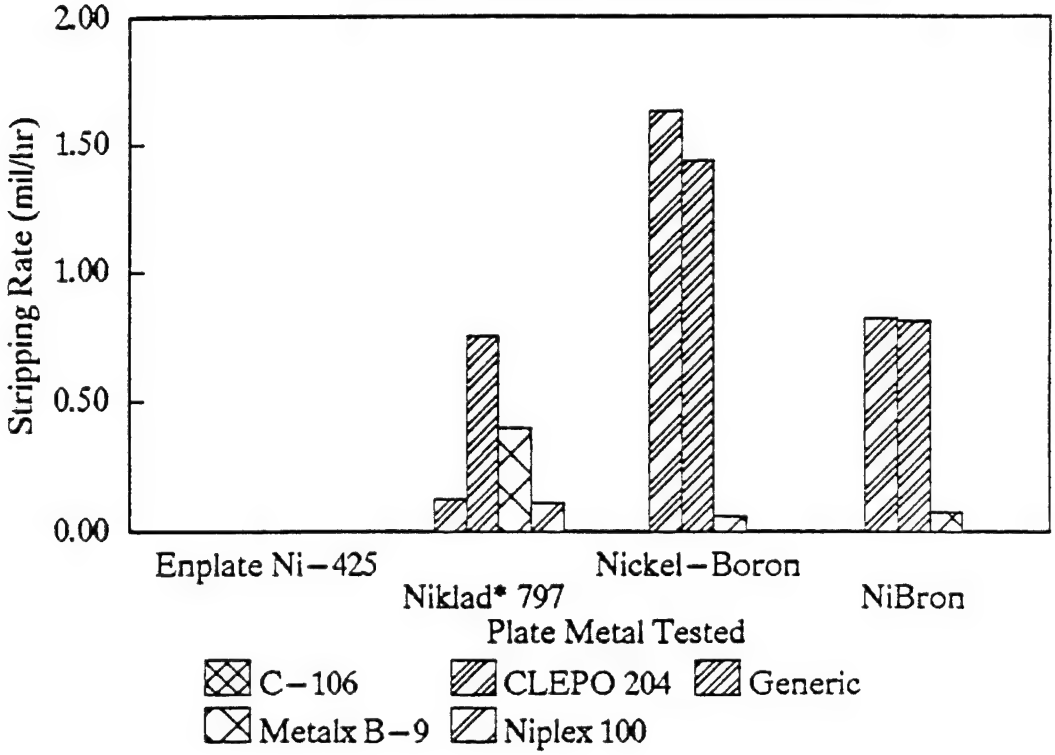


Basis Metal Regeneration Tests at 130F

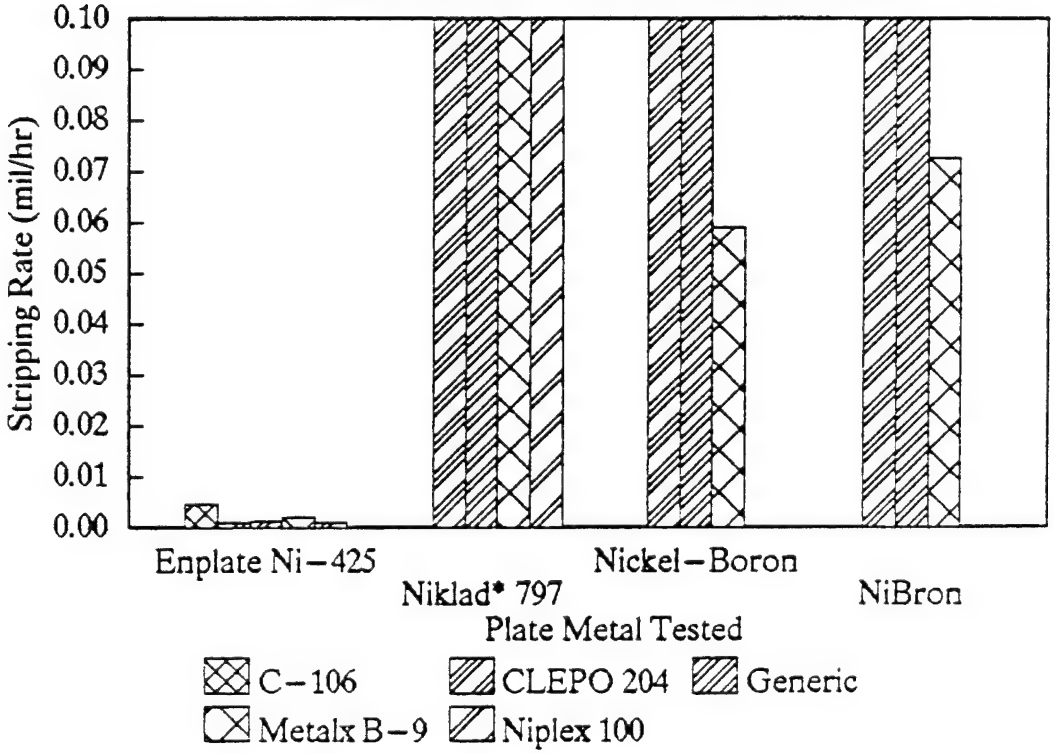


Alternative Plate Material Stripping

Comparison of Nickel Plate Materials

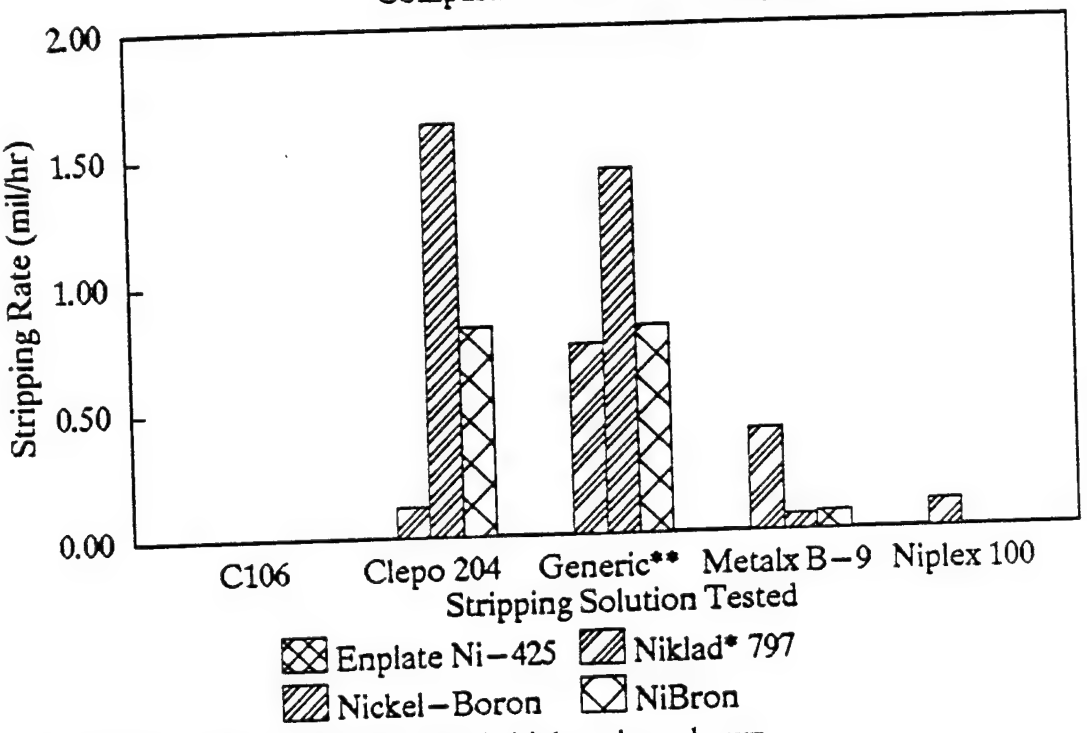


Scale expanded to enhance baseline values



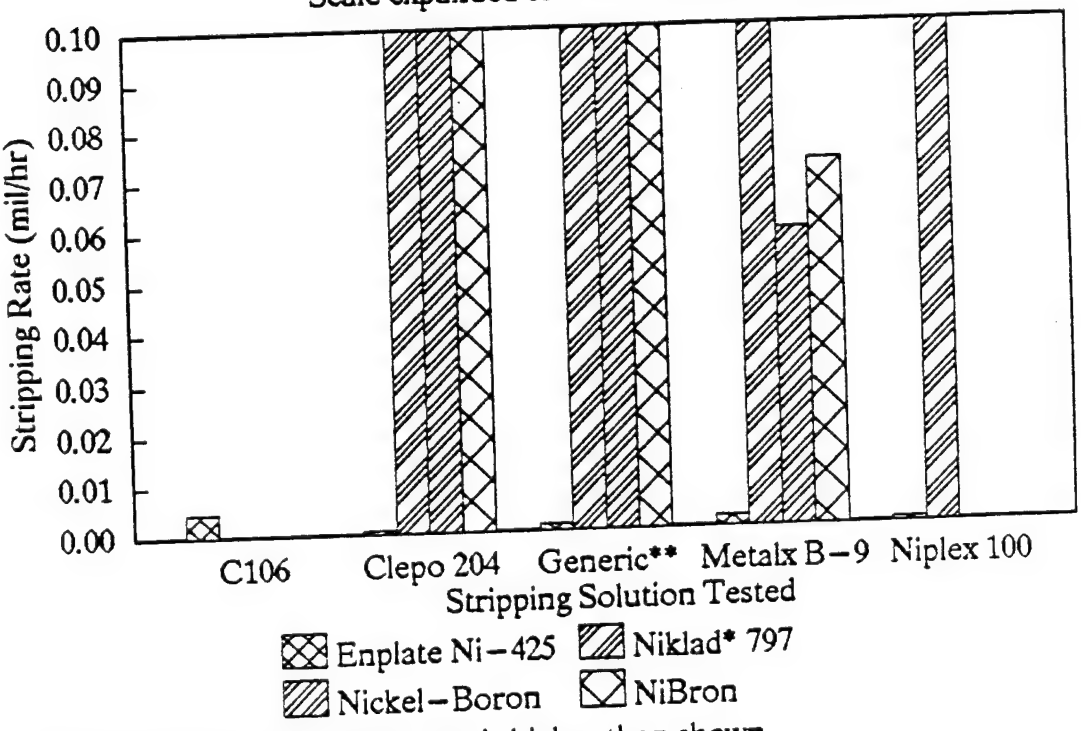
Alternative Plate Material Stripping

Comparison of Various Strippers



** Nickel-Boron stripping rate is higher than shown.

Scale expanded to enhance baseline values



** Nickel-Boron stripping rate is higher than shown.

APPENDIX I

EXPERIMENTAL DATA FROM BIOREACTOR TESTING

The Tables on the following pages contain the data obtained from the bench-scale bioreactor experiments. The following legend supports the data found below.

Numbers reported in ppm:

TOC (Total Organic Carbon)

COD (Chemical Oxygen Demand)

ED (Ethylenediamine)

Amm. (Ammonia) in the form NH_4^+.

NO_3^- (Nitrate)

NO_2^- (Nitrite)

SO_4^{2-} (Sulfate)

PO_4^{3-} (Phosphate)

DO (Dissolved Oxygen)

MLSS (Mixed-Liquor-Suspended-Solids)

Numbers having other units:

SOUR (Specific Oxygen Uptake Rate) reported in mg Oxygen consumed per mL per minute.

SSV 15 (Sludge Settled Volume) at 15 minutes.

SSV 30 (Sludge Settled Volume) at 30 minutes.

SSV 45 (Sludge Settled Volume) at 45 minutes.

SVI (Sludge Volume Index) reported in mL per gram.

Other abbreviations or information:

pH is self explanatory.

pH Bioreact. = the pH of the fluid in the bioreactor.

Ef. = effluent

In. = influent

NT = not taken

Column #1 Data

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
0 Hrs.	65.7	66.1	30	26	0	0	0	0
24	65.7	66.1	30	26	0	0	0	0
24	110.5	59.9	157	26	47.8	0	0	0
32	110.5	76.5	157	120	47.8	10.0	0	0
48	100.7	77.3	131	17	44.0	17.8	0	0
54	100.7	80.9	131	124	44.3	37.4	0	0
60	100.7	71.5	131	113	44.0	37.8	0	0
72	83.5	90.1	97	61	49.0	46.0	0	0
78	113.6	82.6	115	46	73.6	67.7	0	0
84	89.2	89.7	122	73	74.9	73.3	0	0
96	85.6	89.5	124	147	76.7	69.2	0	0
102	87.4	63.6	147	153	76.7	73.5	0	0
108	87.0	78.8	147	193	76.7	78.5	0	0
120	104.1	94.7	116	128	79.1	59.2	0	0
126	104.1	79.4	116	89	79.1	66.8	0	0
132	104.1	87.4	116	70	79.1	68.5	0	0
144	96.8	91.9	89	75	79.1	85.3	0	0
144	96.8	91.9	89	75	88.7	85.3	0	0
168	96.8	83.5	89	115	88.7	87.4	0	0.2
192	96.8	85.8	89	215	88.7	83.3	0	0
198	89.2	75.6	122	88	88.7	59.7	0	2.6
216	89.2	72.6	122	90	88.7	0	0	19.0
222	80.6	51.8	115	116	88.7	0	0	26.6
240	80.6	64.1	115	43	88.7	0	0	27.0
264	80.6	65.0	115	0	88.7	0	0	26.3
264	137.9	65.0	115	65	137.2	0	0	26.3
270	137.9	98.5	115	92	137.2	0	0	69.9
288	137.9	83.5	115	86	185.1	0	0	63.0
294	168.9	87.5	378	65	197.0	0	0	68.5
312	168.9	83.9	378	77	197.0	0	0	70.8
318	162.4	91.8	341	122	197.0	0	0	75.0
336	162.4	70.5	341	95	197.0	12.0	0	73.3
360	162.4	102.9	126	112	197.0	0	0	61.6
360	153.3	102.9	126	112	233.4	0	0	69.9
366	153.3	91.3	126	80	233.4	0	0	69.9
384	153.3	92.5	126	78	233.4	0	0	74.2
390	153.3	95.3	555	83	278.4	0	0	66.8
408	209.1	135.4	555	178	278.4	0	0	106.9
414	209.1	125.0	555	186	278.4	0	0	106.9
432	209.1	105.0	555	153	278.4	0	0	106.9
438	209.1	103.8	500	163	278.4	0	0	106.9
456	128.3	79.4	500	82	278.4	0	0	106.9
462	128.3	97.3	501	172	278.4	0	0	106.9
480	186.3	86.6	501	167	278.4	0	0	106.9
504	186.3	111.5	214	188	278.4	0	0	106.9
528	220.6	84.9	214	82	278.4	72.0	0	106.9
552	220.6	132.5	214	142	332.7	0	0	108.0
576	220.6	131.4	492	170	332.7	0	0	106.9

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
600	120.6	94.9	492	185	347.9	0	0	125.7
606	120.6	81.6	492	233	347.9	0	0	125.7
624	120.6	86.4	489	223	347.9	0	0	112.4
630	179.1	83.5	489	115	347.9	0	0	134.7
648	179.1	84.3	489	118	347.9	0	0	131.7
672	179.1	95.6	696	91	384.7	0	0	114.1
696	256.2	99.6	696	162	384.7	0	0	147.8
702	256.2	128.3	696	87	384.7	0	0	138.8
720	256.2	120.0	692	72	384.7	0	0	144.6
720	256.2	120.0	692	72	630.9	0	0	144.6
726	241.8	119.9	774	35	630.9	0	0	120.2
744	205.0	87.6	774	46	630.9	0	0	123.8
768	205.0	126.6	774	175	630.9	0	0	119.1
774	205.0	140.5	675	65	630.9	0	0	119.1
792	222.6	125.9	675	105	630.9	0	0	119.1
798	222.6	125.0	710	133	630.9	0	0	119.1
816	223.0	101.0	710	111	630.9	0	0	119.1
840	223.0	95.5	710	71	630.9	0	0	119.1
864	223.0	84.6	710	78	630.9	0	0	119.1
870	246.0	96.3	777	58	630.9	0	0	119.1
888	246.0	92.6	777	41	630.9	0	0	119.1
894	256.2	114.5	696	95	699.2	0	0	144.6
912	241.8	112.8	692	63	699.2	0	0	130.5
918	241.8	105.5	692	159	699.2	0	0	137.6

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
0	3.3	1.4	0	0	81.9	112.6	1.6	2.2
24	3.3	1.4	0	0	81.9	112.6	1.6	2.2
24	4.6	1.8	0.98	0	127.9	186.0	1.6	2.0
32	4.6	1.8	0.98	NT	127.9	NT	1.6	NT
48	4.2	NT	0.89	NT	112.4	NT	0	NT
54	4.2	2.9	0.89	0	112.4	217.7	0	2.93
60	4.2	3.9	0.89	0	112.4	195.0	0	2.4
72	2.3	3.2	0	0	204.5	138.3	0	2
78	2.3	1.9	0	0	204.0	222.2	0	2.2
84	2.3	1.1	0	0	204.0	243.8	0	2.5
96	17.8	0	9.2	0	168.3	139.0	0	2.5
102	17.8	11.5	9.2	2.4	168.3	246.7	0	2.6
108	17.8	14.7	9.2	3.8	168.3	250.9	0	3.0
120	8.6	12.8	8.6	6.0	161.2	228.4	1.6	3.3
126	8.6	9.5	8.6	2.5	161.2	173.3	1.6	7.4
132	8.6	7.7	8.6	1.0	161.2	164.0	1.6	3.0
144	4.5	6.6	2.5	3.6	187.9	201.8	0	3.9
168	6.6	1.9	2.4	0	212.4	259.4	2.1	3.4
192	6.1	4.3	1.9	0	174.3	196.2	2.2	2.9
198	6.1	9.8	1.9	0	174.3	195.1	2.2	4.9
216	6.1	2.8	1.9	0	174.3	224.8	2.2	4.6
222	8.0	5.6	4.5	0	226.0	258.0	8.6	9.7
240	8.0	5.9	4.5	0	226.0	246.0	8.6	8.9
264	8.0	6.3	4.5	0	226.0	279.7	8.6	9.6

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
264	8.4	0	4.5	0	320.9	365.9	13.8	7.9
270	8.4	5.0	4.5	0	320.9	350.0	13.8	8.0
288	8.4	5.7	4.5	0	320.9	363.6	13.8	8.3
294	8.4	6.8	4.5	0	320.9	385.6	13.8	8.8
312	8.4	5.1	4.5	0	403.6	358.1	7.9	8.1
318	8.4	5.1	4.5	0	403.6	360.2	7.9	8.2
336	8.4	5.0	4.5	0	403.6	306.6	7.9	7.4
360	8.1	5.0	0	0	399.3	405.1	7.5	8.1
366	8.1	5.5	0	0	399.3	380.7	7.5	8.5
384	8.1	5.5	0	0	399.3	380.7	7.5	8.5
390	9.1	4.9	4.6	0	401.4	343.6	7.8	8.8
408	9.1	6.5	4.6	0	401.4	320.5	7.8	7.7
414	9.1	0	4.6	0	401.4	456.3	7.8	8.2
432	7.7	0	3.9	0	433.5	437.7	7.9	7.6
438	7.7	0	3.9	0	433.5	438.1	7.9	7.8
456	7.7	0	3.9	0	433.5	462.8	7.9	7.5
462	7.7	0	3.9	0	433.5	462.8	7.9	7.5
480	7.7	0	3.9	0	433.5	462.8	7.9	7.5
504	7.7	0	3.9	0	433.5	432.8	7.9	7.5
528	7.7	0	3.9	0	433.5	432.8	7.9	7.5
552	7.7	0	3.9	0	433.5	432.8	7.9	7.5
576	8.6	0	3.9	0	461.1	483.1	0	0
600	8.6	6.2	0	0	461.1	486.3	0	0
606	8.6	6.2	0	0	461.1	486.3	0	0
624	7.3	0	0	0	309.2	486.7	0	0
630	7.3	5.5	0	3.7	309.2	410.3	0	0
648	7.3	5.5	0	3.7	309.2	410.3	0	0
672	10.2	0	0	0	542.8	347.3	0	0
696	10.2	0	0	0	542.8	530.0	0	0
702	10.2	0	0	0	542.8	451.4	0	0
720	6.0	0	0	0	530.6	534.3	0	0
726	6.0	4.7	0	0	530.6	467.9	0	0
744	6.0	0	0	0	530.6	585.9	0	0
768	6.0	0	0	0	530.6	610.4	0	0
774	6.0	5.0	0	0	530.6	619.5	0	0
792	6.0	4.6	0	0	530.6	692.6	0	0
798	6.0	0	0	0	530.6	644.6	0	0
816	7.4	0	6.3	0	692.9	794.3	14.4	0
840	7.4	0	6.3	0	692.9	785.0	14.4	7.4
864	10.6	4.9	0	4.2	732.0	729.0	7.4	8.0
870	10.6	4.6	0	3.7	732.0	674.0	7.4	0
888	10.6	0	0	0	732.0	773.0	7.4	0
894	10.6	0	0	3.7	732.0	758.0	7.4	0
912	5.7	5.1	5.4	4.8	646.0	756.0	0	0
918	5.7	5.1	5.4	4.8	646.0	756.0	0	0

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
0	8.9	0.15	3050	140	115	100	37.7
24	8.9	0.15	3050	140	115	100	37.7
24	9.1	0.18	4130	170	135	120	32.7
32	9.5	0.16	NT	NT	NT	NT	NT
48	9.2	0.12	3350	180	160	100	47.7
54	9.1	0.12	2660	150	120	110	45.1
60	9.7	0.05	NT	NT	NT	NT	NT
72	9.7	0.11	2760	110	90	80	32.6
78	9.2	0.08	2770	170	140	125	50.5
84	8.9	0.07	NT	NT	NT	NT	NT
96	9.4	0.16	3080	125	100	90	32.5
102	8.8	0.12	2930	90	75	70	25.6
108	9.4	0.09	NT	NT	NT	NT	NT
120	9.0	0.18	2780	85	70	65	25.2
126	9.2	0.22	4280	170	140	125	32.7
132	9.1	0.27	NT	NT	NT	NT	NT
144	8.8	0.15	3670	160	130	115	35.4
168	9.5	0.14	3260	130	105	95	32.2
192	10.5	0.14	3010	130	105	95	34.9
198	9.4	0.09	1750	155	125	110	71.4
216	8.9	0.22	5330	255	200	180	37.5
222	8.5	0.27	6020	250	200	180	33.2
240	8.6	0.20	4520	230	185	165	40.9
264	9.3	0.28	5930	275	220	195	37.1
264	8.3	0.22	4500	220	175	160	38.9
270	6.7	0.45	2070	160	130	120	62.8
288	9.6	0.49	8430	365	290	260	34.4
294	8.4	0.42	7130	405	320	280	44.9
312	9.3	0.42	5880	340	270	240	45.9
318	8.4	0.38	6780	325	255	225	37.6
336	9.2	0.28	5900	295	235	210	39.8
360	9.2	0.18	5020	280	220	195	43.8
366	9.3	0.21	5630	265	210	185	37.3
384	8.9	0.24	4980	265	210	185	42.2
390	8.8	0.85	5590	260	210	180	37.6
408	8.3	0.42	4490	160	140	125	31.2
414	7.7	0.51	3470	120	105	95	30.2
432	8.5	0.25	4310	160	130	120	30.1
438	8.2	0.35	4500	155	130	120	28.8
456	8.2	0.41	4380	220	180	160	41.1
462	8.3	0.56	5550	245	200	185	36.0
480	8.1	0.35	5250	235	195	170	37.1
504	8.4	0.27	5600	250	210	190	37.5
528	8.7	0.44	5210	250	205	180	39.3
552	9.1	0.36	4950	230	190	170	38.4
576	8.2	0.22	5280	250	205	180	38.8
600	8.3	0.36	5030	250	210	90	41.7
606	9.4	0.19	6230	285	235	210	37.7
624	8.1	0.43	5490	260	215	195	39.2
630	8.4	0.34	4630	230	185	165	40.0
648	7.4	0.79	4470	230	190	170	42.5

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
672	7.3	2.23	4580	225	185	170	40.4
696	6.4	0.37	5080	245	200	180	39.4
702	7.9	0.76	4920	240	200	175	40.6
720	6.2	1.09	5940	295	245	220	41.2
726	6.8	0.61	4320	260	220	195	30.9
744	6.9	0.77	5860	325	270	240	46.1
768	4.3	0.73	5940	310	250	220	42.1
774	5.5	0.59	5430	300	250	220	46.0
792	3.5	0.92	5760	305	250	220	43.0
798	4.1	0.66	5880	295	240	220	40.8
816	6.8	0.66	5940	300	250	220	42.1
840	4.5	0.45	4960	300	240	220	48.4
864	3.3	0.08	5420	300	240	220	44.3
870	4.2	1.30	5090	280	225	200	44.2
888	2.5	0.07	4920	275	220	200	44.7
894	3.6	0.64	4670	270	220	200	47.1
912	3.5	0.92	4710	270	220	195	46.7
918	7.8	2.70	4890	270	220	200	45.0

Time	pH In.	pH Bioreact.	pH Ef.
0	7	8.2	8.07
24	7	8.2	8.07
24	7	8	7.93
32	7	7.84	7.89
48	7	8	NT
54	7	7.9	7.77
60	7	8.11	7.73
72	7	8.12	8.0
78	7	7.3	7.75
84	7	NT	NT
96	7	8.23	8.09
102	7	8.05	7.82
108	7	NT	NT
120	7	8.12	7.82
126	7	7.91	7.6
132	7	NT	NT
144	7	7	8.22
168	7	8.37	8.11
192	7	7	7.94
198	7	8.08	8.08
216	7	8.11	7.8
222	7	7.82	7.53
240	7	8	8.05
246	7	8	8.03
264	7	8.4	8.2
270	7	8.17	7.94
288	7	8.18	8.14
294	7	8.06	8.05
312	7	8.28	8.02
318	7	8.1	8.15

Time	pH In.	pH Bioreact.	pH Ef.
336	7	8.02	8.18
360	7	8.09	8.13
366	7	8.08	8
384	7	8.21	8.26
390	7	8.18	7.9
408	7	7.97	8.05
414	7	7.77	7.79
432	7	8.17	7.91
438	7	8	7.89
456	7	8	7.89
462	7	7.97	7.9
480	7	7.97	8.12
504	7	7.8	7.86
528	7	7.89	7.81
552	7	8.09	7.96
576	7	7.99	8.14
600	7	8	8
606	7	8	8.04
624	7	7.8	8.02
630	7	7.93	7.86
648	7	8.05	8.1
672	7	8	8.2
696	7	8.1	8.1
702	7	8	8
720	7	8	8
726	7	8.2	8.2
744	7	8.2	8.1
768	7	7.9	7.88
774	7	8	8.2
792	7	7.9	7.9
798	7	8	7.8
816	7	8	7.9
840	7	7.8	7.8
864	7	7.8	7.9
870	7	7.7	7.8
888	7	7.7	7.7
894	7	7.8	7.6
912	7	7.9	7.8
918	7	8	7.9

Column #2 Data

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
0 Hrs.	65.8	65.5	30	26	0	0	0	0
24	70.0	62.2	23	20	0	0	0	0
32	70.0	58.4	23	53	0	0	0	0
48	59.6	54.2	19	35	0	0	0	0
54	58.7	46.5	60	36	0	0	0	0
60	58.0	48.2	60	54	0	0	0	0
72	71.0	52.3	100	17	0	0	0	0
72	100.0	52.3	118	17	32.7	0	0	0
78	100.0	48.6	118	20	32.7	33	0	0
96	96.2	74.8	110	4	30.2	28.9	0	0
102	96.2	101.9	110	64	30.2	31.3	0	0
108	96.2	99.6	110	163	30.2	32.8	0	0
120	109.7	114.5	144	170	49.1	36.5	0	0
126	109.7	121.7	144	153	49.1	46.8	0	0
132	109.7	102.3	144	157	49.1	47.8	0	0
144	119.7	100.4	156	106	54.7	52.6	0	0
168	115.9	111.5	175	119	65.5	65.3	0	0
192	115.9	106.5	175	121	65.5	61.6	0	0
198	115.9	111.6	175	156	65.5	61.6	0	0
216	115.9	98.2	175	170	65.5	65.3	0	0
222	96.2	88.3	105	125	65.5	0	0	4.2
240	96.2	74.7	105	88	32.6	0	0	8.2
264	96.2	88.3	105	0	32.9	0	0	14.6
264	102.3	88.3	107	0	32.9	0	0	14.6
270	102.3	83.3	107	145	32.9	0	0	16.4
288	104.7	92.9	178	92	32.9	0	0	17.3
294	104.7	84.6	178	92	32.9	0	0	15.8
312	104.7	81.6	178	62	32.9	24.1	0	15.1
318	107.9	79.2	224	69	36.5	0	0	14.4
336	107.9	79.7	224	96	36.5	0	0	13.3
360	75.6	88.4	256	41	36.5	0	0	14.2
366	75.6	65.3	256	38	36.5	0	0	14.2
384	75.6	73.7	256	36	36.5	0	0	14.2
390	76.4	73.2	222	46	36.5	0	0	14.2
408	76.4	75.2	222	48	36.5	0	0	14.2
414	104.0	67.0	222	23	36.5	0	0	14.2
432	104.0	75.0	197	13	36.5	0	0	14.2
438	113.4	68.0	197	45	36.5	0	0	14.2
456	113.4	71.9	204	36	70.6	0	0	20.2
462	113.4	70.0	204	35	70.6	0	0	25.9
480	125.3	62.3	204	46	70.6	0	0	19.3
504	125.3	59.0	212	58	70.6	0	0	19.3
528	125.3	48.0	212	45	72.9	0	0	16.8
552	123.5	65.0	212	55	72.9	0	0	29.4
576	123.5	62.5	231	74	72.9	0	0	29.4
600	123.5	64.4	231	105	73.7	0	0	29.4
606	132.4	54.3	277	122	73.7	0	0	31.1
624	132.4	50.8	277	166	73.7	0	0	29.5

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
630	138.1	54.8	277	70	81.8	0	0	29.5
648	138.1	60.5	277	44	81.8	0	0	34.3
672	138.1	60.8	228	83	81.8	0	0	30.8
696	143.2	59.0	228	35	81.8	0	0	31.1
702	143.2	67.4	302	67	81.8	0	0	29.5
720	143.2	83.0	302	57	81.8	0	0	29.5
726	144.8	75.7	322	31	88.6	0	0	29.5
744	118.8	75.6	322	62	88.6	0	0	29.5
768	144.8	79.5	322	58	88.6	0	0	29.5
774	144.8	75.0	322	152	130.8	0	0	29.5
792	150.1	61.8	327	53	130.8	0	0	28.7
798	150.1	80.0	327	74	130.8	0	0	28.7
816	156.6	92.9	327	33	157.4	0	0	31.0
840	156.6	79.6	327	40	157.4	0	0	34.3

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
0	2.9	0.83	0	0	91.2	84.0	1.6	4.3
24	2.9	1.8	0	0	91.2	118.0	1.6	2.0
32	2.9	1.8	0	0	91.2	118.0	1.6	2.0
48	4.2	9.9	0.95	0	72.6	114.5	0	1.1
54	4.2	3.7	0.95	0	72.6	134.3	0	2.3
60	4.2	4.0	0.95	0	72.6	112.7	0	2.2
72	2.5	3.9	0	0	238.0	93.2	0	2.2
72	0.95	2.4	0	0	241.9	172.2	1.8	2.7
78	2.5	1.2	0	0	238.0	238.7	0	2.3
96	18.7	8.0	14.3	0	281.9	305.2	1.7	2.3
102	18.7	8.0	14.3	3.5	281.9	305.2	1.7	2.4
108	18.7	9.5	14.3	5.7	281.9	320.3	1.7	2.5
120	8.8	5.2	9.8	4.9	247.0	248.1	1.8	2.1
126	8.8	6.6	9.8	3.9	247.0	303.4	1.8	3.6
132	8.8	7.2	9.8	1.1	247.0	313.5	1.8	4.1
144	4.6	3.9	3.0	2.0	275.8	269.2	2.0	3.8
168	6.8	0	2.3	0	275.7	317.3	2.3	3.4
192	5.0	1.9	2.2	0	210.3	292.1	2.1	2.5
198	5.0	2.7	2.2	0	210.3	309.8	2.1	2.7
216	5.0	1.8	2.2	0	210.3	248.6	2.1	3.9
222	5.0	5.2	2.2	0	210.3	290.7	2.1	11.3
240	5.0	4.9	2.2	0	210.3	314.3	2.1	9.4
264	5.0	4.9	2.2	0	210.3	297.5	2.1	9.3
264	5.0	4.9	2.2	0	307.8	315.5	8.2	9.2
270	5.0	5.4	2.2	0	307.8	275.1	8.2	8.7
288	5.0	6.6	2.2	0	307.8	295.3	8.2	8.7
294	5.0	7.7	2.2	0	307.8	307.7	8.2	9.7
312	5.0	7.1	2.2	0	307.8	319.9	8.2	8.6
318	8.6	6.0	2.2	0	307.7	284.3	7.5	8.0
336	8.6	8.1	2.2	0	307.7	282.8	7.5	8.4
360	8.3	7.5	0	0	332.0	284.7	7.4	8.6
366	8.3	8.4	0	0	332.0	297.6	7.4	8.9

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
384	8.3	8.7	0	4.3	332.0	221.0	7.4	7.8
390	8.7	7.1	0	0	221.0	331.5	7.4	9.2
408	8.7	7.0	0	3.7	221.0	300.5	7.4	9.7
414	8.7	7.8	0	0	221.0	259.5	7.4	9.4
432	8.7	10.3	0	3.7	221.0	245.4	7.4	9.7
438	8.7	11.6	0	0	221.0	265.0	7.4	9.9
456	8.7	9.9	0	3.7	221.0	247.8	7.4	8.9
462	8.7	9.9	0	3.7	221.0	247.8	7.4	8.9
480	10.4	14.5	0	0	228.1	271.3	0	0
504	10.4	14.5	0	0	228.1	271.3	0	0
528	10.4	14.5	0	0	228.1	271.3	0	0
552	10.4	14.5	0	0	228.1	271.3	0	0
576	10.4	14.5	0	0	228.1	271.3	0	0
600	10.4	17.5	0	0	228.1	271.3	0	0
606	10.4	17.5	0	0	228.1	271.3	0	0
624	6.6	17.5	0	0	228.1	284.6	0	0
630	6.6	17.5	0	0	228.1	284.6	0	0
648	6.6	15.0	0	0	228.1	274.5	0	0
672	9.9	7.8	0	0	333.7	247.7	0	0
696	9.9	11.9	0	0	333.7	303.8	0	0
702	9.9	13.2	0	0	333.7	309.1	0	7.5
720	9.9	13.2	0	0	333.7	304.3	0	0
726	9.9	14.2	0	0	333.7	306.0	0	0
744	9.9	15.9	0	0	333.7	358.2	0	0
768	7.4	13.6	0	0	437.0	400.0	8.02	0
774	7.4	18.6	0	0	437.0	402.8	8.02	0
792	7.4	17.0	0	0	437.0	427.9	8.02	0
798	7.4	17.6	0	0	437.0	424.0	8.02	0
816	0	16.2	4.2	0	412.0	458.0	0	0
840	0	20.5	4.2	0	412.0	415.0	0	0

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
0	9.0	0.11	2730	130	105	95	38.5
24	9.0	0.09	2720	110	90	85	33.1
32	9.6	0.13	NT	NT	NT	NT	NT
48	9.1	0.03	2510	180	140	125	55.8
54	8.9	0.06	2080	115	100	90	48.1
60	9.5	0.05	NT	NT	NT	NT	NT
72	9.6	0.11	2450	105	90	85	36.7
72	9.3	0.13	2430	110	95	90	39.1
78	8.9	0.10	NT	NT	NT	NT	NT
96	9.5	0.25	2490	90	70	65	28.1
102	8.9	0.09	2390	70	60	55	25.1
108	9.2	0.11	NT	NT	NT	NT	NT
120	8.8	0.18	2730	75	60	60	22.0
126	9.3	0.22	3530	140	115	100	32.6
132	9.0	0.27	NT	NT	NT	NT	NT
144	8.8	0.12	3420	150	120	110	35.1
168	9.8	0.21	2740	110	90	85	32.9
192	10.3	0.17	3090	135	110	100	35.6

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
198	9.3	0.10	2110	90	75	70	35.6
216	8.9	0.28	5520	260	205	180	37.1
222	8.7	0.30	5350	260	205	180	38.3
240	8.8	0.18	4520	240	195	170	43.1
264	8.7	0.26	5930	290	235	205	39.6
264	8.5	0.21	4520	220	190	170	42.0
270	7.1	0.43	1820	170	140	130	76.9
288	9.2	0.37	8250	365	290	255	35.2
294	8.9	0.33	8140	380	305	270	37.5
312	9.6	0.48	6950	355	285	250	41.0
318	8.7	0.32	7700	350	280	245	36.4
336	9.1	0.27	6240	315	250	220	40.0
360	9.5	0.19	5049	295	240	215	47.5
366	9.3	0.23	5310	275	215	190	40.5
384	9.1	0.14	4600	260	210	185	45.7
390	9.5	0.29	5780	275	220	195	38.1
408	9.1	0.18	4980	260	210	185	42.2
414	9.3	0.25	5000	245	195	180	39.0
432	9.6	0.15	7070	330	260	230	36.7
438	8.5	0.18	7090	500	375	315	52.8
456	9.5	0.27	5580	300	240	215	43.0
462	9.5	0.30	6060	310	250	220	41.2
480	9.4	0.19	4780	245	195	180	40.8
504	9.3	0.12	4420	215	180	160	40.7
528	8.8	0.09	3860	190	155	140	40.2
552	10.5	0.12	3460	175	140	130	40.5
576	9.2	0.17	4340	210	170	155	40.1
600	9.1	0.09	3710	170	140	130	37.7
606	10.2	0.07	4360	205	165	150	37.8
624	9.2	0.11	3750	160	130	125	34.7
630	9.3	0.13	3680	170	140	130	38.0
648	8.9	0.09	3380	155	130	120	38.5
672	8.6	0.10	2760	135	110	100	39.9
696	9.6	0.09	3270	140	120	110	36.7
702	10.2	0.15	3610	160	135	125	37.4
720	8.6	0.23	3800	175	145	135	38.2
726	8.5	0.28	3400	170	140	130	41.2
744	8.7	0.20	3320	190	155	145	46.7
768	8.3	0.19	3410	150	130	120	38.1
774	6.9	0.19	3460	145	125	115	36.1
792	7.5	0.13	3600	145	120	115	33.3
798	8.0	0.16	3370	130	110	105	32.6
816	8.3	0.17	3390	150	140	120	41.3
840	9.7	0.23	3490	140	120	110	34.4

Time	pH In.	pH Bioreact.	pH Ef.	m-NBA In.	m-NBA Ef.
0	7.05	8.2	8.07	0	0
24	7	7.77	7.84	0	0
32	7	7.96	7.88	0	0
48	7	8	NT	0	0

Time	pH In.	pH Bioreact.	pH Ef.	m-NBA In.	m-NBA Ef.
54	7	7.75	7.77	0	0
60	7	8.15	7.63	0	0
72	7	8.21	7.95	0	0
72	7	8	7.71	9.1	0
78	7	NT	NT	9.1	4
96	7	8.3	8.1	9.1	5.9
102	7	8.14	7.97	9.1	9.0
108	7	NT	NT	9.1	9.1
120	7	8.11	7.76	14.3	12.4
126	7	7.98	7.53	14.3	12.7
132	7	NT	NT	14.3	12.9
144	7	7	8.21	16.5	15.0
168	7	8.41	8.24	19.8	15.2
192	7	7	7.9	19.8	19.0
198	7	8.2	8.2	19.8	18.3
216	7	8.16	7.84	8.3	19.1
222	7	7.87	7.58	8.3	10.1
240	7	8	8	8.3	7.0
264	7	8	8	8.8	6.6
264	7	8.3	8.2	8.8	6.6
270	7	8.16	7.82	8.8	4.5
288	7	8.16	7.96	8.8	3.8
294	7	7.97	7.93	8.8	3.4
312	7	8.18	7.97	8.8	2.6
318	7	7.98	7.96	8.8	2.1
336	7	8.06	8.14	8.8	1.5
360	7	8	7.92	8.8	0
366	7	7.94	7.95	8.8	0
384	7	8.13	8.16	8.8	0
390	7	8.08	7.79	8.8	0
408	7	7.75	7.8	8.8	0
414	7	7.73	7.72	8.8	0
432	7	7.94	7.85	8.8	0
438	7	7.91	7.59	8.8	0
456	7	7.9	7.9	17.5	0
462	7	7.8	7.8	17.5	0
480	7	7.92	7.82	17.5	0
504	7	8	7.97	17.9	0
528	7	7.96	7.5	17.9	0
552	7	7.98	7.68	17.9	0
576	7	7.85	7.92	17.9	0
600	7	8	8	17.9	0
606	7	8	8	17.9	0
624	7	7.7	7.5	17.9	0
630	7	7.89	7.6	24.1	0
648	7	8	8	24.1	0
672	7	8	8.08	24.1	0
696	7	8.04	7.7	24.1	0
702	7	7.95	7.6	24.1	0
720	7	7.9	7.9	24.1	0
726	7	7.9	7.9	26.8	0

Time	pH In.	pH Bioreact.	pH Ef.	m-NBA In.	m-NBA Ef.
744	7	8.08	7.7	26.8	0
768	7	7.9	7.89	26.8	0
774	7	7.8	7.5	39.4	0
792	7	8	7.5	39.4	0
798	7	7.9	7.8	39.4	0
816	7	8.06	7.67	47.8	0
840	7	7.8	7.9	47.8	0

Column #3 Data

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
0	65.7	65.6	30	18	0	0	0	0
24	70.0	59.3	23	21	0	0	0	0
32	70.0	58.0	23	87	0	0	0	0
48	59.7	58.0	19	13	0	0	0	0
54	58.7	48.9	42	43	0	0	0	0
60	58.7	50.5	42	46	0	0	0	0
72	0	52.3	0	25	0	0	0	0
78	45.6	45.6	18	23	0	0	0	0
84	45.6	52.1	18	0	0	0	0	0
96	79.4	66.5	35	15	0	0	0	0
102	79.4	59.6	35	82	0	0	0	0
108	79.4	85.7	35	47	0	0	0	0
120	83.6	74.2	39	20	0	0	0	0
126	83.6	63.3	39	87	0	0	0	0
132	83.6	62.7	39	10	0	0	0	0
144	92.4	57.7	32	25	0	0	0	0
168	87.0	65.3	42	0	0	0	0	0
192	75.9	70.8	7	12	0	0	0	0
198	75.9	58.8	7	25	0	0	0	0
216	75.9	57.0	7	30	0	0	0	0
222	67.5	45.1	55	123	0	0	0	0
240	67.5	59.6	55	26	0	0	0	0
264	67.5	59.6	55	0	0	0	0	0
264	87.0	65.4	98	25	0	0	0	0
270	87.0	57.7	98	30	0	0	0	0
288	67.8	58.6	57	44	0	0	0	0
294	67.8	55.8	57	22	0	0	0	0
312	67.8	58.3	57	43	0	0	0	0
318	61.0	55.8	31	17	0	0	0	0
336	61.0	50.6	31	15	0	0	0	0
360	72.3	57.0	50	13	0	0	0	0
366	72.3	56.8	50	18	0	0	0	0
384	72.3	60.2	50	26	0	0	0	0
390	103.3	54.0	204	20	0	0	0	0
408	103.3	71.0	204	40	0	0	0	0
414	103.3	64.6	204	23	0	0	0	0
432	76.2	68.4	81	48	0	0	0	0
438	76.2	60.0	81	57	0	0	0	0
456	76.2	51.5	81	22	0	0	0	0
462	76.2	55.3	81	32	0	0	0	0
480	75.4	39.1	145	51	0	0	0	0
504	75.4	52.3	145	70	0	0	0	0
528	63.3	52.5	71	31	0	0	0	0
552	63.3	55.4	71	31	0	0	0	0
576	41.9	43.6	85	22	0	0	0	0
600	41.9	36.3	85	92	0	0	0	0
606	41.9	40.2	85	105	0	0	0	0
624	58.1	44.1	41	20	0	0	0	0

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
630	58.1	46.4	41	24	0	0	0	0
648	58.1	48.5	41	18	0	0	0	0
672	55.7	50.0	20	11	0	0	0	0
696	55.7	53.9	20	15	0	0	0	0
702	55.7	43.6	20	15	0	0	0	0
720	51.7	47.3	35	18	0	0	0	0
726	51.7	48.4	35	35	0	0	0	0
744	51.7	48.2	35	10	0	0	0	0
768	62.2	42.6	81	19	0	0	0	0
774	62.2	60.6	81	28	0	0	0	0
792	62.2	72.1	81	58	0	0	0	0
798	62.2	60.6	81	0	0	0	0	0
816	61.1	64.0	111	6	0	0	0	0
840	61.1	53.0	111	94	0	0	0	0
864	46.8	54.0	32	49	0	0	0	0
870	46.8	42.5	32	30	0	0	0	0
888	46.8	40.9	32	66	0	0	0	0
894	46.8	36.0	32	46	0	0	0	0
912	56.7	42.4	40	21	0	0	0	0
918	56.7	36.4	40	17	0	0	0	0

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
0	2.9	1.9	0	0	91.2	132.2	1.6	2.3
24	2.9	1.9	0	0	91.2	132.2	1.6	2.3
32	2.9	0.91	0	0	91.2	99.1	1.6	1.9
48	4.2	2.4	0.95	0	72.6	106.0	0	1.9
54	4.2	2.4	0.95	0	72.6	106.0	0	1.9
60	4.2	3.2	0.95	0	72.6	113.3	0	2.4
72	2.2	3.2	0	0	117.5	120.8	3.2	2.2
78	2.2	2.1	0	0	117.5	203.2	3.2	2.6
84	2.2	1.6	0	0	117.5	209.2	3.2	2.4
96	19.2	1.3	14.9	0	159.2	172.0	1.7	2.5
102	19.2	11.4	14.9	9.1	159.2	130.4	1.7	2.2
108	19.2	11.4	14.9	9.1	159.2	130.4	1.7	2.2
120	8.1	3.3	8.5	2.2	128.5	45.9	2.8	0
126	8.1	9.0	8.5	3.2	128.5	165.7	2.8	3.4
132	8.1	9.8	8.5	1.5	128.5	182.0	2.8	4.5
144	4.6	5.6	3.2	2.1	268.7	144.2	1.9	4.0
168	6.1	1.9	2.3	0	153.8	174.4	2.2	3.3
192	5.6	3.3	1.7	0	114.2	164.5	2.2	2.6
198	5.6	3.8	1.7	0	114.2	151.3	2.2	11.9
216	5.6	3.8	1.7	0	114.2	155.0	2.2	4.3
222	7.5	7.4	4.8	0	226.4	195.4	8.6	8.4
240	7.5	7.1	4.8	0	226.4	245.1	8.6	9.9
264	7.5	7.1	4.8	0	226.4	226.9	8.6	9.5
264	0	6.5	0	0	184.8	212.1	8.3	0
270	0	5.9	0	0	184.8	177.1	8.3	8.1
288	0	5.9	0	0	184.8	192.5	8.3	9.5
294	0	7.2	0	0	184.8	198.1	8.3	9.5
312	0	7.6	0	0	184.8	197.1	8.3	8.9

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
318	7.7	6.2	0	0	158.9	183.0	0	8.8
336	7.7	6.2	0	0	158.9	156.7	0	8.6
360	8.3	6.1	0	0	240.4	161.6	7.3	8.7
366	8.3	6.1	0	0	240.4	166.7	7.3	8.9
384	8.3	5.8	0	0	240.4	236.8	7.3	9.6
390	8.8	7.2	4.4	0	125.8	296.8	7.8	12.5
408	8.8	4.7	4.4	0	125.8	160.9	7.8	9.8
414	8.8	0	4.4	0	125.8	143.6	7.8	9.9
432	7.2	0	3.7	0	114.8	117.0	7.9	9.2
438	7.2	0	3.7	0	114.8	128.9	7.9	9.6
456	7.2	0	3.7	0	114.8	134.8	7.9	8.5
462	7.2	0	3.7	0	114.8	134.8	7.9	8.5
480	8.4	4.6	0	0	114.8	122.0	0	0
504	8.4	4.6	0	0	114.8	122.0	0	0
528	8.4	4.6	0	0	114.8	122.0	0	0
552	8.4	4.6	0	0	114.8	122.0	0	0
576	8.2	5.2	0	0	160.6	166.0	0	0
600	8.2	7.1	0	0	160.6	168.8	0	0
606	8.2	6.7	0	0	160.6	147.0	0	0
624	8.3	6.3	0	0	95.0	162.3	0	0
630	8.3	7.0	0	0	95.0	104.0	0	0
648	8.3	7.5	0	0	95.0	98.3	0	0
672	10.2	6.8	0	0	138.5	110.7	0	7.5
696	10.2	9.4	0	0	138.5	121.0	0	8.1
702	10.2	10.0	0	0	138.5	126.7	0	7.4
720	6.6	9.6	0	0	146.3	124.0	0	0
726	6.6	8.8	0	0	146.3	118.0	0	0
744	6.6	7.5	0	0	146.3	154.0	0	0
768	9.9	7.3	0	0	219.0	162.0	0	0
774	9.9	8.2	0	0	219.0	174.0	0	0
792	9.9	8.8	0	0	219.0	209.0	0	0
798	9.9	10.6	0	0	219.0	209.0	0	0
816	7.9	8.5	6.1	0	247.0	217.0	15.2	8
840	7.9	7.2	6.1	0	247.0	228.0	15.2	9.8
864	9.9	8.6	0	0	154.0	269.0	0	0
870	9.9	8.6	0	0	154.0	218.0	0	0
888	9.9	11.3	0	0	154.0	169.0	0	7.6
894	9.9	11.4	0	0	154.0	162.0	0	0
912	6.1	11.5	5.2	0	135.0	168.0	0	7.5
918	6.1	11.5	5.2	0	135.0	168.0	0	7.5

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
0	9.1	0.16	2370	110	95	90	40.1
24	9.2	0.12	2560	120	100	90	39.1
32	9.6	0.15	NT	NT	NT	NT	NT
48	9.4	0.07	2190	130	110	100	50.2
54	9.2	0.09	2120	120	100	90	47.2
60	9.8	0.03	NT	NT	NT	NT	NT
72	9.7	0.12	2520	90	80	70	35.7

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
78	9.5	0.07	2310	120	100	90	43.2
84	8.9	0.11	NT	NT	NT	NT	NT
96	9.5	0.19	2550	100	80	80	31.4
102	8.8	0.14	2270	80	70	70	30.8
108	9.5	0.11	NT	NT	NT	NT	NT
120	9.2	0.24	2550	90	75	70	29.4
126	9.3	0.24	3200	165	135	125	42.2
132	9.2	0.18	NT	NT	NT	NT	NT
144	9.1	0.06	3070	155	130	115	42.3
168	10.5	0.16	2530	120	100	90	39.5
192	10.2	0.17	2490	145	105	105	42.1
198	9.3	0.09	1980	95	80	75	40.4
216	9.2	0.21	5270	290	230	205	43.6
222	8.9	0.23	4920	250	200	175	40.6
240	9.2	0.18	4330	220	180	160	41.5
264	8.9	0.17	5330	270	210	190	39.3
264	8.5	0.14	3420	185	140	130	40.9
270	7.9	0.26	1600	155	130	120	81.2
288	9.5	0.39	6920	335	270	240	39.0
294	9.4	0.29	6080	330	260	230	42.8
312	9.9	0.24	5680	290	230	205	40.5
318	9.0	0.28	5450	275	220	185	40.6
336	9.2	0.15	5150	250	195	175	37.8
360	9.8	0.13	4160	220	175	155	42.1
366	9.6	0.13	4080	200	160	140	39.2
384	9.5	0.11	3950	190	150	140	38.0
390	9.8	0.18	4130	200	160	145	38.7
408	9.4	0.12	2480	100	80	75	32.3
414	9.2	0.33	1360	55	50	45	36.7
432	9.9	0.14	2110	70	65	60	30.8
438	9.3	0.03	1390	50	45	40	32.3
456	9.8	0.29	2940	100	85	80	28.9
462	9.7	0.16	4460	190	160	150	35.8
480	9.6	0.14	3890	190	155	140	39.8
504	9.4	0.12	4460	195	160	150	35.9
528	9.2	0.04	4290	200	160	150	37.3
552	10.9	0.12	3510	160	130	120	37.0
576	9.5	0.07	3970	195	160	145	40.3
600	9.3	0.12	4310	200	160	145	37.1
606	10.5	0.14	5400	240	190	175	35.1
624	9.5	0.14	4440	240	190	170	42.8
630	9.5	0.12	3720	170	130	125	34.9
648	9.3	0.07	3260	160	130	120	39.9
672	9.2	0.10	2940	135	110	100	42.5
696	9.6	0.09	3270	130	110	100	36.1
702	10.2	0.07	2880	125	105	95	36.4
720	9.5	0.19	2480	140	115	105	56.4
726	9.7	0.27	3510	160	130	120	47.6
744	9.1	0.06	3480	185	150	135	43.0
768	9.3	0.15	2880	140	110	100	38.2
774	8.8	0.28	3100	125	100	90	32.3

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
792	9.1	0.08	3450	130	110	100	31.9
798	8.6	0.11	3320	125	100	95	30.1
816	9.2	0.04	3150	180	105	100	33.3
840	10.4	0.07	2910	140	105	100	36.1
864	7.7	0.08	3080	135	110	100	35.7
870	13.6	0.16	2590	125	100	90	38.6
888	9.1	0.06	2550	125	100	95	39.2
894	7.6	0.08	1950	100	80	75	41.0
912	8.2	0.07	2070	110	90	80	43.4
918	8.9	0.06	2400	100	80	75	33.3

Time	pH In.	pH Bioreact.	pH Ef.
0	7	8.2	8.0
24	7	7.7	7.8
32	7	8.0	7.9
48	7	8.0	NT
54	7	7.6	7.8
60	7	8.1	7.7
72	7	8.2	7.9
78	7	8.0	7.7
84	7	NT	NT
96	7	8.3	8.1
102	7	8.1	8.0
108	7	NT	NT
120	7	8.1	7.7
126	7	7.9	7.5
132	7	NT	NT
144	7	7.0	8.2
168	7	8.3	8.2
192	7	7.8	7.8
198	7	8.2	8.0
216	7	8.1	7.8
222	7	7.8	7.5
240	7	8.0	8.0
264	7	8.0	8.0
264	7	8.3	8.1
270	7	8.1	7.8
288	7	8.1	8.0
294	7	8.0	7.9
312	7	8.1	7.9
318	7	8.0	8.0
336	7	8.0	8.1
360	7	8.0	7.9
366	7	8.0	7.9
384	7	8.1	8.1
390	7	8.1	7.7
408	7	7.7	7.7
414	7	7.7	7.6
432	7	7.9	7.7

Time	pH In.	pH Bioreact.	pH Ef.
438	7	7.9	7.6
456	7	7.9	7.9
462	7	7.8	7.8
480	7	7.9	7.8
504	7	7.9	7.8
528	7	7.9	7.8
552	7	8.0	7.7
576	7	7.8	7.9
600	7	7.9	7.9
606	7	8.0	7.8
624	7	7.7	7.8
630	7	7.9	7.7
648	7	8.0	7.9
672	7	8.0	8.0
696	7	7.9	7.7
702	7	7.9	7.7
720	7	7.8	7.8
726	7	7.9	8.0
744	7	8.2	7.8
768	7	8.0	7.8
774	7	7.8	7.7
792	7	8.1	7.6
798	7	7.9	7.7
816	7	8.0	7.7
840	7	7.8	7.7
864	7	7.9	7.9
870	7	7.8	7.6
888	7	7.7	7.5
894	7	7.8	7.5
912	7	7.9	7.5
918	7	8.1	7.7

Column #4 Data

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
0	67.9	69.1	30	25	0	0	0	0
24	81.4	77.3	26	27	0	0	0	0
32	81.0	74.8	26	28	0	0	0	0
48	64.5	68.7	31	68	0	0	0	0
54	59.7	66.8	42	56	0	0	0	0
60	59.0	73.3	42	46	0	0	0	0
72	75.0	70.5	48	36	0	0	0	0
78	75.0	74.0	48	23	0	0	0	0
84	75.0	81.6	48	0	0	0	0	0
96	89.1	80.5	35	13	0	0	0	0
102	89.1	79.7	35	35	0	0	0	0
108	89.1	63.6	35	33	0	0	0	0
120	91.5	89.5	34	25	0	0	0	0
126	91.5	86.8	34	64	0	0	0	0
132	91.5	87.5	34	0	0	0	0	0
144	75.0	83.9	25	10	0	0	0	0
168	82.9	80.3	0	23	0	0	0	0
192	76.3	83.4	55	46	0	0	0	0
198	76.3	75.5	55	46	0	0	0	0
216	76.3	68.8	55	21	0	0	0	0
222	71.7	65.4	35	56	0	0	0	0
240	71.7	78.1	35	39	0	0	0	0
264	71.7	74.9	35	0	0	0	0	0
264	98.9	75.4	104	29	0	0	0	0
270	98.9	71.6	104	23	0	0	0	0
288	76.3	74.9	69	58	0	0	0	0
294	76.3	69.0	69	19	0	0	0	0
312	76.3	71.7	69	58	0	0	0	0
318	68.4	68.5	22	17	0	0	0	0
336	68.4	61.7	22	14	0	0	0	0
360	76.8	69.4	46	19	0	0	0	0
366	76.8	68.1	46	12	0	0	0	0
384	76.8	72.6	46	28	0	0	0	0
390	109.3	64.9	205	24	0	0	0	0
408	109.3	81.4	205	40	0	0	0	0
414	109.3	74.1	205	22	0	0	0	0
432	84.4	74.7	90	34	0	0	0	0
438	84.4	68.0	90	38	0	0	0	0
456	84.4	57.3	90	16	0	0	0	0
462	84.4	58.5	90	16	0	0	0	0
480	51.7	49.3	110	61	0	0	0	0
504	51.7	61.7	110	8	0	0	0	0
528	66.5	64.0	53	56	0	0	0	0
552	66.5	63.3	53	63	0	0	0	0
576	48.8	50.2	70	32	0	0	0	0
600	48.8	47.8	70	101	0	0	0	0
606	48.8	52.1	70	117	0	0	0	0

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
624	66.1	58.2	41	45	0	0	0	0
630	66.1	57.9	41	18	0	0	0	0
648	66.1	59.3	41	53	0	0	0	0
672	61.4	59.8	29	28	0	0	0	0
696	61.4	63.4	29	40	0	0	0	0
702	61.4	55.9	29	25	0	0	0	0
720	68.1	57.1	33	11	0	0	0	0
726	68.1	57.7	33	32	0	0	0	0
744	68.1	59.8	33	14	0	0	0	0
768	61.7	49.9	49	16	0	0	0	0
774	61.7	71.3	49	35	0	0	0	0
792	61.7	82.7	49	67	0	0	0	0
798	61.7	70.9	49	1	0	0	0	0
816	67.4	76.8	8	4	0	0	0	0
840	67.4	67.8	8	53	0	0	0	0
864	53.5	56.5	22	42	0	0	0	0
870	53.5	52.9	22	65	0	0	0	0
888	53.5	51.1	22	46	0	0	0	0
894	53.5	35.8	22	35	0	0	0	0
912	61.2	54.3	40	18	0	0	0	0
918	61.2	49.9	40	22	0	0	0	0

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
0	3.2	1.9	0	0	79.7	79.5	0	0
24	3.2	1.9	0	0	79.7	79.5	0	0
32	3.2	1.9	0	0	79.7	79.5	0	0
48	4.1	3.2	0	0	72.5	71.7	2.1	2.0
54	4.1	3.2	0	0	72.5	71.7	2.1	2.0
60	4.1	3.2	0	0	72.5	71.7	2.1	2.0
72	2.5	4.0	0	0	204.5	139.0	0	1.9
78	2.5	2.4	0	0	204.5	77.7	0	5.9
84	2.5	1.8	0	0	204.5	90.0	0	7.4
96	17.1	1.1	13.2	0	123.7	107.6	1.9	1.9
102	17.1	13.6	13.2	6.4	123.7	195.2	1.9	2.9
108	17.1	13.6	13.2	6.4	123.7	195.2	1.9	2.9
120	8.3	7.7	9.7	8.6	109.1	110.0	1.8	1.9
126	8.3	10.0	9.7	7.4	109.1	141.0	1.8	2.7
132	8.3	9.9	9.7	5.5	109.1	140.6	1.8	3.9
144	4.9	9.6	3.4	6.4	138.3	129.8	2.1	5.1
168	6.6	3.7	2.5	0	140.0	160.4	1.8	3.3
192	6.2	4.5	2.0	0	102.5	130.3	2.1	2.2
198	6.2	5.7	2.0	0	102.5	117.5	2.1	3.5
216	6.2	5.7	2.0	0	102.5	127.3	2.1	5.3
222	8.4	8.3	4.9	0	190.9	146.8	8.6	9.7
240	8.4	7.4	4.9	0	190.9	159.9	8.6	9.0
264	8.4	7.8	4.9	0	190.9	171.4	8.6	9.4
264	0	7.0	4.5	0	135.4	180.1	8.4	0
270	0	5.7	4.5	0	135.4	121.5	8.4	9.0
288	0	5.8	4.5	0	135.4	131.0	8.4	10.3

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
294	0	7.5	4.5	0	135.4	146.5	8.4	8.9
312	0	7.6	4.5	0	135.4	161.7	8.4	9.4
318	7.3	8.4	3.8	0	140.9	166.9	8.3	9.5
336	7.3	7.3	3.8	0	140.9	141.4	8.3	8.9
360	7.9	6.9	0	0	193.5	148.0	7.6	9.1
366	7.9	7.4	0	0	193.5	135.9	7.6	13.7
384	7.9	7.4	0	0	193.5	135.9	7.6	13.7
390	8.2	6.9	4.2	0	100.3	191.3	7.5	9.8
408	8.2	4.6	4.2	0	100.3	130.9	7.5	9.7
414	8.2	0	4.2	0	100.3	115.6	7.5	10.6
432	6.1	0	0	0	104.5	117.4	7.6	11.4
438	6.1	0	0	0	104.5	119.5	7.6	9.6
456	6.1	0	0	0	104.5	119.5	7.6	9.6
462	6.1	0	0	0	104.5	119.5	7.6	9.6
480	6.1	4.6	0	0	104.5	116.9	7.6	0
504	6.1	7.6	0	0	104.5	127.2	7.6	0
528	9.5	7.6	3.7	0	150.3	120.3	0	0
552	9.5	7.3	3.7	0	150.3	162.5	0	0
576	7.8	5.5	0	0	141.8	170.4	0	0
600	7.8	7.9	0	0	141.8	135.8	0	0
606	7.8	7.8	0	0	141.8	131.8	0	0
624	7.8	15.4	0	0	86.8	288.7	0	0
630	7.8	7.5	0	0	86.8	93.3	0	0
648	7.8	9.0	0	0	86.8	92.7	0	0
672	1.7	8.7	0	0	105.0	97.0	0	7.4
696	1.7	11.7	0	0	105.0	102.0	0	7.5
702	1.7	12.1	0	0	105.0	101.0	0	7.5
720	6.9	11.3	0	0	127.0	100.0	10.3	0
726	6.9	11.2	0	0	127.0	112.0	10.3	0
744	6.9	8.6	0	0	127.0	109.0	10.3	0
768	9.3	8.4	0	0	184.0	115.0	7.8	0
774	9.3	8.2	0	0	184.0	175.0	7.8	0
792	9.3	9.3	0	0	184.0	180.0	7.8	0
798	9.3	9.3	0	0	184.0	198.0	7.8	0
816	7.9	8.3	6.1	0	215.0	181.0	15.5	7.5
840	7.9	7.3	6.1	0	215.0	259.0	15.5	7.7
864	10.6	6.8	0	0	134.0	246.0	0	8.8
870	10.6	7.8	0	0	134.0	180.0	0	0
888	10.6	10.2	0	0	134.0	142.0	0	0
894	9.8	6.5	0	4.3	134.0	119.0	0	7.6
912	10.1	6.5	0	4.3	123.0	119.0	0	7.6
918	10.1	6.0	0	0	123.0	116.0	0	7.6

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
0	9.0	0.10	2730	110	*90	80	33.0
24	8.9	0.05	2430	95	80	70	32.9
32	9.5	0.12	NT	NT	NT	NT	NT
48	9.1	0.04	1960	110	90	80	45.9
54	9.0	0.07	1990	80	70	60	35.2

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
60	9.6	0.02	NT	NT	NT	NT	NT
72	9.8	0.12	2050	105	60	55	29.3
78	9.4	0.04	1960	80	70	70	35.7
84	9.0	0.06	NT	NT	NT	NT	NT
96	9.2	0.15	2320	80	70	60	30.2
102	9.0	0.15	2070	55	50	45	24.2
108	9.1	0.10	NT	NT	NT	NT	NT
120	9.0	0.15	2250	70	60	55	26.7
126	9.3	0.21	3840	155	125	110	32.6
132	8.8	0.20	NT	NT	NT	NT	NT
144	8.5	0.06	3210	135	110	100	34.2
168	9.7	0.22	2590	100	85	80	32.8
192	10.2	0.11	3270	130	100	95	30.5
198	9.2	0.09	2220	110	85	80	36.0
216	8.8	0.22	5230	260	205	185	39.2
222	8.3	0.19	4740	240	190	170	40.0
240	9.0	0.17	4220	215	170	150	40.2
264	8.5	0.14	5360	255	200	175	37.3
264	8.3	0.12	3780	190	150	135	39.6
270	6.6	0.22	1540	165	140	130	90.9
288	8.3	0.32	9560	490	390	340	40.8
294	8.6	0.27	8380	510	400	350	47.7
312	9.5	0.20	7630	470	380	330	49.8
318	8.2	0.20	7510	385	305	215	40.6
336	9.0	0.15	6030	340	260	230	43.1
360	9.3	0.11	5760	310	240	210	41.7
366	9.3	0.14	5330	270	210	185	39.4
384	9.1	0.09	4710	240	190	170	40.3
390	9.1	0.16	4850	240	185	165	38.1
408	7.8	0.17	3330	190	150	135	45.0
414	7.8	0.26	3180	145	130	115	40.8
432	9.4	0.15	5880	220	215	190	36.5
438	8.8	0.08	5290	240	190	170	35.9
456	9.5	0.19	5000	245	195	175	39.0
462	9.2	0.20	6580	300	240	215	36.4
480	8.4	0.11	5710	260	215	190	37.7
504	8.3	0.08	5290	250	200	180	37.8
528	8.3	0.08	5090	250	200	175	39.3
552	9.9	0.10	5110	250	200	180	39.1
576	9.0	0.09	5110	260	200	180	39.1
600	8.6	0.10	4920	250	210	185	42.6
606	9.8	0.09	5930	280	220	190	37.1
624	9.1	0.07	5320	260	200	180	37.6
630	9.0	0.12	4520	220	170	150	37.6
648	8.8	0.05	4160	200	160	140	38.5
672	8.9	0.08	2810	170	135	120	48.0
696	8.6	0.04	3530	180	140	130	39.7
702	9.5	0.06	2820	140	110	100	39.0
720	7.1	0.07	2260	190	150	130	66.4
726	7.6	0.07	3740	230	185	160	49.5
744	7.1	0.05	3350	210	165	145	49.3

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
768	7.4	0.10	3110	200	160	140	51.4
774	5.2	0.07	2840	180	140	125	49.3
792	6.7	0.11	3270	200	160	140	48.9
798	6.4	0.02	2950	190	150	130	50.8
816	7.2	0.06	2700	180	125	120	46.3
840	6.5	0.10	NT	140	115	100	NT
864	6.0	0.02	2520	170	135	120	53.6
870	8.7	0.08	1530	205	160	140	104.5
888	4.9	0.02	1220	200	160	140	131.1
894	5.2	0.03	1030	170	140	120	135.9
912	6.4	0.12	940	180	145	130	154.2
918	8.0	0.53	3480	150	120	110	34.5

Time	pH In.	pH Bioreact.	pH Ef.
0	8.5	8.3	8.1
24	8.5	8.2	8.1
32	8.5	8.1	8.0
48	8.5	8.2	NT
54	8.5	8.3	8.1
60	8.5	8.3	8.0
72	8.5	8.3	8.3
78	8.5	8.3	8.2
84	NT	NT	NT
96	8.5	8.4	8.3
102	8.5	8.3	8.2
108	NT	NT	NT
120	8.5	8.2	7.9
126	8.5	8.4	8.1
132	NT	NT	NT
144	8.5	8.5	8.5
168	8.5	8.5	8.3
192	8.5	8.5	8.0
198	8.5	8.3	8.0
216	8.5	8.2	7.9
222	8.5	8.0	7.7
240	8.5	8.2	8.2
264	8.5	8.1	8.0
264	8.5	8.2	8.2
270	8.5	8.2	7.0
288	8.5	8.2	8.0
294	8.5	8.0	7.8
312	8.5	8.1	7.9
318	8.5	8.0	8.0
336	8.5	8.0	8.1
360	8.5	8.1	7.9
366	8.5	8.1	8.0
384	8.5	8.1	8.1
390	8.5	8.1	7.7
408	8.5	7.7	7.7
414	8.5	7.6	7.5

Time	pH In.	pH Bioreact.	pH Ef.
432	8.5	7.9	7.8
438	8.5	7.9	7.7
456	8.5	8.0	8.0
462	8.5	7.8	7.8
480	8.5	7.9	7.8
504	8.5	7.8	7.7
528	8.5	7.8	7.6
552	8.5	7.9	7.8
576	8.5	7.7	7.9
600	8.5	7.9	7.9
606	8.5	7.9	7.8
624	8.5	7.7	7.9
630	8.5	7.9	7.7
648	8.5	8.1	7.9
672	8.5	8.1	7.9
696	8.5	8.0	7.8
702	8.5	7.9	7.8
720	8.5	7.9	7.9
726	8.5	7.9	7.9
744	8.5	8.2	7.9
768	8.5	8.1	8.0
774	8.5	8.0	7.8
792	8.5	8.1	7.8
798	8.5	8.0	7.9
816	8.5	8.0	7.8
840	8.5	7.8	7.7
864	8.5	7.9	7.9
870	8.5	7.9	7.7
888	8.5	7.9	7.7
894	8.5	8.0	7.6
912	8.5	8.0	7.6
918	8.5	8.0	7.7

Column #5 Data

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
0	65.7	69.7	30	41	0	0	0	0
24	81.4	74.5	26	25	0	0	0	0
32	81.4	74.5	26	83	0	0	0	0
48	64.5	69.3	31	33	0	0	0	0
54	59.7	68.5	42	60	0	0	0	0
60	59.7	72.5	42	33	0	0	0	0
72	80.8	93.1	48	22	0	0	0	0
72	108.0	93.1	137	22	18.3	0	0	0
78	108.0	75.9	137	120	18.3	18.4	0	0
96	108.0	102.0	137	123	18.9	18.4	0	0
102	108.0	118.0	137	137	18.9	18.4	0	0
108	1109.0	108.0	137	140	18.9	18.4	0	0
120	111.7	111.4	114	104	28.7	20.3	0	0
126	111.7	105.5	147	145	28.7	27.9	0	0
132	120.1	111.6	147	107	28.7	27.9	0	0
144	124.8	127.5	155	167	34.5	36.0	0	0
168	124.8	121.9	155	155	34.5	36.7	0	0
192	134.8	132.3	167	167	43.3	38.5	0	0
198	146.4	139.9	170	173	55.9	45.7	0	0
216	146.4	142.1	176	180	55.9	60.0	0	2.7
222	146.4	146.4	176	195	55.9	25.0	0	7.0
240	82.9	106.0	147	69	24.6	19.5	0	0
264	82.9	111.6	155	0	24.6	0	0	11.3
264	82.9	111.6	155	104	24.6	0	0	11.3
270	84.7	96.7	155	93	24.6	0	0	16.2
288	84.7	77.7	155	96	24.6	0	0	15.8
294	84.7	95.1	198	77	24.6	0	0	18.7
312	124.8	97.5	198	77	24.6	0	0	12.1
318	124.8	92.0	95	62	29.5	13.2	0	13.2
336	132.5	79.3	193	50	29.5	0	0	12.7
360	132.5	90.5	193	39	29.5	0	0	14.2
366	132.5	86.3	193	47	29.5	0	0	13.9
384	127.2	89.7	198	50	29.5	0	0	14.0
390	127.2	80.6	198	49	29.5	0	0	13.4
408	148.3	90.1	217	28	59.2	0	0	13.4
414	148.3	81.8	217	21	59.2	0	0	15.5
432	148.3	86.4	217	63	59.2	0	0	18.5
438	148.3	83.8	255	78	59.2	0	0	11.8
456	147.6	76.9	255	48	59.2	0	0	28.4
462	147.6	72.5	220	53	59.7	0	0	28.4
480	147.6	62.3	220	76	59.7	0	0	28.4
504	120.1	78.0	220	138	59.7	0	0	28.4
528	120.1	77.8	231	54	59.7	0	0	28.4
552	134.8	77.0	231	113	59.7	0	0	28.4
576	150.5	63.7	217	55	62.8	0	0	28.4
600	150.5	63.7	217	75	62.8	0	0	28.4
606	150.5	66.1	217	99	62.8	0	0	18.7
624	150.5	72.0	217	42	62.8	0	0	23.1

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
630	150.0	64.5	217	40	62.8	0	0	25.7
648	150.0	74.7	217	62	82.1	0	0	29.3
672	159.0	80.9	289	40	82.1	0	0	29.8
696	159.0	93.1	289	83	82.1	0	0	29.8
702	159.0	83.3	289	102	85.3	0	0	29.8
720	159.0	82.0	289	52	85.3	0	0	30.0
726	159.0	80.8	289	38	85.3	0	0	30.3
744	159.0	84.9	289	53	85.3	0	0	31.0
768	159.0	67.7	317	62	108.7	0	0	32.0
774	160.0	96.5	317	66	108.7	0	0	28.5
792	160.0	107.0	324	97	108.7	0	0	32.2
798	160.0	95.0	377	46	127.0	0	0	26.1
816	166.5	99.7	377	110	127.0	0	0	34.6
840	166.5	102.6	377	84	127.0	0	0	34.6

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
0	3.2	1.0	0	0	79.7	96.3	0	1.9
24	3.2	1.0	0	0	79.7	96.3	0	1.9
32	3.2	1.0	0	0	79.7	96.3	0	1.9
48	4.0	3.2	0.94	0	49.9	92.6	0	2.1
54	4.0	4.4	0.94	0	49.9	85.8	0	2.2
60	4.0	3.7	0.94	0	49.9	57.9	0	2.2
72	2.2	3.7	0	0	117.5	58.1	3.2	2.1
78	0.94	3.1	2.4	0	224.7	131.8	0	9.8
84	0.94	1.7	2.4	0	224.7	140.5	0	2.0
96	15.3	0.7	13.0	0	234.2	184.9	1.6	1.9
102	15.3	6.8	13.0	9.7	234.2	258.5	1.6	2.0
108	15.3	7.2	13.0	15.8	234.2	299.7	1.6	2.1
120	8.0	2.9	12.2	12.9	235.3	228.0	1.8	1.9
126	8.0	4.5	12.2	10.8	235.3	244.5	1.8	2.6
132	8.0	5.2	12.2	3.9	235.3	199.8	1.8	2.9
144	4.5	4.5	3.1	3.2	213.3	196.5	2.0	5.2
168	9.3	1.7	2.1	0	232.9	265.8	1.8	2.8
192	5.5	2.9	2.9	0	218.7	269.3	2.0	2.7
198	5.5	2.6	2.9	0	218.7	184.6	2.0	2.8
216	5.5	1.5	2.9	0	218.7	219.3	2.0	4.2
222	9.3	1.5	4.9	0	233.3	219.3	8.0	4.2
240	9.3	7.7	4.9	0	233.3	178.6	8.0	9.5
264	9.3	5.7	4.9	0	233.3	249.3	8.0	8.5
264	7.7	5.2	3.9	0	259.6	240.7	7.7	8.0
270	7.7	5.2	3.9	0	259.6	240.7	7.7	8.0
288	7.7	6.3	3.9	0	259.6	237.2	7.7	9.25
294	7.7	7.1	3.9	0	259.6	264.3	7.7	9.3
312	7.7	6.9	3.9	0	259.6	272.5	7.7	8.8
318	7.4	6.9	3.6	0	259.1	271.1	7.6	8.8
336	7.4	8.2	3.6	0	259.1	227.3	7.6	8.5
360	7.5	6.8	3.6	3.7	306.1	263.4	7.7	8.7
366	7.5	10.7	3.6	0	306.1	259.8	7.7	9.0

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
384	7.5	10.7	3.6	0	306.1	259.8	7.7	9.0
390	8.4	7.4	4.3	0	187.0	279.3	7.8	9.1
408	8.4	7.0	4.3	3.7	187.0	268.4	7.8	9.3
414	8.4	8.5	4.3	3.7	187.0	285.5	7.8	9.3
432	8.4	9.3	4.3	0	225.1	226.6	8.7	9.7
438	8.4	9.0	4.3	0	225.1	205.9	8.7	9.3
456	8.4	8.1	4.3	3.9	225.1	251.8	8.7	9.2
462	8.4	8.1	4.3	3.9	225.1	251.8	8.7	9.2
480	8.4	7.1	4.3	0	225.1	220.7	8.7	9.2
504	8.4	7.1	4.3	0	225.1	220.7	8.7	9.2
528	6.3	7.1	0	0	243.7	220.7	0	0
552	6.3	7.1	0	0	243.7	220.7	0	0
576	6.4	10.0	0	0	287.2	247.9	0	0
600	6.4	17.1	0	0	287.2	261.3	0	0
606	6.4	13.7	0	0	287.2	277.5	0	0
624	6.5	14.7	0	0	241.3	284.9	0	0
630	6.5	14.7	0	0	241.3	284.9	0	0
648	6.5	12.6	0	0	241.3	262.9	0	0
672	9.7	11.7	0	0	321.0	267.0	0	0
696	9.7	11.5	0	0	321.0	294.0	0	0
702	9.7	15.2	0	0	321.0	339.0	0	7.4
720	5.5	13.6	0	0	378.0	320.0	8.9	0
726	5.5	13.1	0	0	378.0	275.0	8.9	0
744	5.5	14.9	0	0	378.0	360.0	8.9	0
768	7.2	15.7	0	0	382.0	381.0	8.1	0
774	7.2	16.4	0	4.1	382.0	323.0	8.1	0
792	7.2	15.3	0	0	382.0	393.0	8.1	0
798	7.2	15.7	0	4.5	382.0	409.0	8.1	0
816	0	18.5	0	0	375.0	446.0	7.9	6.1
840	0	19.4	0	5.0	375.0	411.0	7.9	0

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
0	8.9	0.14	2810	140	120	110	42.7
24	9.1	0.07	3010	135	110	100	36.5
32	9.5	0.12	NT	NT	NT	NT	NT
48	9.3	0.09	2570	140	120	110	46.6
54	9.0	0.03	2090	100	85	80	40.7
60	9.7	0.03	NT	NT	NT	NT	NT
72	9.7	0.06	2320	85	75	70	32.3
78	9.3	0.04	1580	78	70	60	44.3
84	9.0	0.06	NT	NT	NT	NT	NT
96	9.3	0.12	1780	40	40	40	22.5
102	8.8	0.05	1830	40	35	35	19.1
108	9.5	0.04	NT	NT	NT	NT	NT
120	9.1	0.06	1850	30	30	30	16.2
126	9.1	0.27	3040	100	85	80	28
132	9.1	0.24	NT	NT	NT	NT	NT
144	8.8	0.11	3070	160	135	120	35.8
168	9.8	0.14	3070	130	105	95	34.2
192	10.4	0.10	2810	105	85	80	30.7

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
198	9.5	0.07	1880	110	90	80	47.9
216	9.1	0.19	5230	275	220	195	42.0
222	8.8	0.22	4930	270	220	190	44.6
240	9.1	0.17	4310	250	200	180	46.4
264	8.9	0.14	5890	300	235	215	39.8
264	8.8	0.10	4290	170	130	120	30.3
270	7.7	0.38	1570	135	110	105	70.0
288	9.4	0.25	6840	320	255	230	37.3
294	8.6	0.32	6290	305	250	225	39.7
312	9.9	0.31	5420	280	220	195	40.6
318	9.0	0.27	5530	260	210	185	37.0
336	9.1	0.18	5840	280	225	200	38.5
360	9.7	0.14	4480	230	180	160	40.2
366	9.6	0.12	4470	225	180	160	40.3
384	9.4	0.17	4010	230	180	160	44.9
390	9.5	0.18	4540	225	180	160	39.6
408	9.3	0.14	3410	160	135	125	39.6
414	9.5	0.23	3290	150	125	120	37.9
432	10.0	0.15	3470	160	135	125	38.9
438	9.3	0.14	3640	125	120	100	34.3
456	9.9	0.21	4390	210	170	155	38.7
462	9.6	0.35	5140	240	190	180	36.9
480	9.7	0.13	3930	190	155	145	39.4
504	9.5	0.06	3730	170	140	130	37.5
528	9.3	0.06	3270	140	120	110	36.7
552	11.0	0.2	3820	170	140	130	36.6
576	9.6	0.11	4690	215	175	160	37.3
600	9.3	0.13	4750	215	170	155	35.7
606	10.5	0.05	4450	200	160	100	35.9
624	9.2	0.12	4680	230	185	165	39.5
630	9.3	0.12	4180	200	160	150	38.3
648	9.2	0.09	3900	195	160	145	41.0
672	9.2	0.17	3660	190	155	140	42.3
696	9.7	0.14	3980	180	150	135	37.7
702	10.3	0.14	3580	160	130	120	36.3
720	9.5	0.24	3470	190	155	140	44.7
726	9.5	0.32	4060	180	150	140	36.9
744	9.1	0.11	3790	190	150	140	39.6
768	9.2	0.18	3710	180	150	140	40.4
774	9.5	0.57	3700	170	140	125	37.8
792	8.7	0.18	3570	160	130	120	36.4
798	9.1	0.37	3720	165	140	130	37.6
816	9.4	0.47	3380	150	130	120	38.5
840	10.9	0.47	4260	170	140	130	32.9

Time	pH In.	pH Bioreact.	pH Ef.	m-NBA In.	m-NBA Ef.
0	8.5	8.3	8.2	0	0
24	8.5	8.2	8.1	0	0
32	8.5	8.2	8.1	0	0
48	8.5	8.2	NT	0	0

Time	pH In.	pH Bioreact.	pH Ef.	m-NBA In.	m-NBA Ef.
54	8.5	8.2	8.2	0	0
60	8.5	8.3	8.0	0	0
72	8.5	8.4	8.3	0	0
78	8.5	8.3	8.2	8.3	1.6
84	NT	NT	NT	8.3	6.1
96	8.5	8.5	8.4	9.4	9.5
102	8.5	8.4	8.3	9.1	9.9
108	NT	NT	NT	9.1	9.1
120	8.5	8.3	8.0	9.1	9.1
126	8.5	7.2	8.3	10.5	10.7
132	NT	NT	NT	10.3	9.1
144	8.5	8.5	8.5	10.3	7.5
168	8.5	8.5	8.4	14.3	9.8
192	8.5	8.5	8.1	14.3	8.7
198	8.5	8.3	8.1	14.3	7.1
216	8.5	8.2	8.0	15.5	13.6
222	8.5	8.2	7.9	15.5	13.6
240	8.5	8.2	8.3	4.5	10.2
264	8.5	8.2	8.2	4.5	9.8
264	8.5	8.4	8.3	4.5	9.8
270	8.5	8.3	8.0	4.5	6.2
288	8.5	8.3	8.2	4.5	4.2
294	8.5	8.2	8.2	5.4	4.2
312	8.5	8.3	8.1	9.2	2.8
318	8.5	8.2	8.2	9.2	1.7
336	8.5	8.2	8.3	9.2	0
360	8.5	8.3	8.1	10.1	0
366	8.5	8.2	8.1	10.1	0
384	8.5	8.3	8.3	10.1	0
390	8.5	8.2	8.1	10.1	0
408	8.5	8.0	7.9	10.1	0
414	8.5	7.9	8.1	10.1	0
432	8.5	7.9	8.0	10.1	0
438	8.5	8.1	7.7	10.1	0
456	8.5	8.0	8.0	10.1	0
462	8.5	8.0	8.0	10.1	0
480	8.5	8.0	7.7	10.1	0
504	8.5	8.2	8.1	10.1	0
528	8.5	8.1	7.9	10.1	0
552	8.5	8.2	7.9	10.1	0
576	8.5	8.0	8.1	13.4	0
600	8.5	8.2	8.5	13.4	0
606	8.5	8.0	8.1	13.4	0
624	8.5	8.0	7.9	17.9	0
630	8.5	8.1	7.7	17.9	0
648	8.5	8.2	8.2	17.9	0
672	8.5	8.2	8.2	20.5	0
696	8.5	8.2	8.0	20.5	0
702	8.5	8.1	7.9	20.5	0
720	8.5	7.9	8.0	20.2	0
726	8.5	7.9	8.0	20.2	0

Time	pH In.	pH Bioreact.	pH Ef.	m-NBA In.	m-NBA Ef.
744	8.5	8.4	8.0	23.6	0
768	8.5	8.2	8.2	23.6	0
774	8.5	8.1	7.9	23.6	0
792	8.5	8.3	7.9	23.6	0
798	8.5	8.2	8.1	23.6	0
816	8.5	8.3	8.0	23.6	0
840	8.5	8.2	8.1	23.6	0

Column #6 Data

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
0	67.9	69.4	30	18	0	0	0	0
24	67.9	69.4	30	18	0	0	0	0
24	89.5	71.8	82	18	31.2	0	0	0
32	89.5	104.9	82	73	31.2	11.2	0	0
48	89.7	101.6	82	104	31.2	30.6	0	0
54	90.3	107.5	85	114	39.4	33.6	0	0
60	90.3	101.3	101	113	39.4	42.7	0	0
72	90.3	108.2	103	110	39.4	41.5	0	0
78	99.6	108.1	103	77	46.4	49.5	0	0
84	99.6	108.0	103	81	46.4	49.5	0	0
96	99.6	108.7	102	93	46.4	46.4	0	0
102	100.9	108.6	113	103	58.8	52.3	0	0
108	101.0	111.4	113	113	58.8	53.4	0	0
120	101.0	109.0	116	124	58.8	58.0	0	0
126	107.2	116.4	116	135	59.6	63.1	0	0
132	107.2	114.6	116	146	59.6	60.0	0	0
144	110.2	104.6	125	150	71.7	65.8	0	0
168	110.2	106.9	125	158	71.7	68.9	0	0
192	110.2	92.2	125	124	71.7	67.4	0	0
198	125.1	95.3	128	136	82.0	79.0	0	0
216	125.1	83.9	143	158	82.0	80.1	0	4.2
222	125.1	89.0	143	164	82.0	76.6	0	11.0
240	135.0	83.9	186	189	100.6	100.4	0	26.3
264	135.0	118.1	186	81	100.6	53.4	0	26.1
264	151.6	83.9	210	81	193.8	53.4	0	26.1
270	151.6	108.6	210	93	193.8	19.0	0	54.1
288	151.6	86.9	210	97	193.8	15.0	0	67.3
294	151.6	116.1	210	65	193.8	11.1	0	33.1
312	150.9	115.6	210	97	193.8	11.5	0	70.8
318	147.1	86.1	340	85	211.8	9.5	0	72.5
336	160.0	94.7	340	104	211.8	10.1	0	74.2
360	160.0	95.5	340	85	211.8	11.1	0	69.2
366	199.7	97.9	395	45	258.8	10.5	0	70.5
384	199.7	84.2	395	33	258.8	9.4	0	75.6
390	204.0	127.2	504	37	268.2	9.4	0	67.6
408	204.0	123.9	504	45	268.2	0	0	67.6
414	204.0	126.1	504	43	268.2	0	0	85.1
432	204.0	129.1	538	144	268.2	0	0	67.61
438	204.0	98.5	538	87	268.2	0	0	100.1
456	204.0	94.5	545	75	268.2	0	0	100.1
462	204.0	77.7	545	121	268.2	0	0	100.1
480	204.0	93.3	504	52	268.2	0	0	100.1
504	204.0	94.0	504	58	268.2	0	0	100.1
528	211.2	104.5	690	104	319.2	0	0	100.1
552	211.2	83.0	690	120	319.2	0	0	116.0
576	234.8	86.1	696	180	375.0	0	0	119.0
600	234.8	89.2	696	75	375.4	0	0	119.0
606	234.8	97.1	696	45	375.4	0	0	119.0

Time	TOC In.	TOC Ef.	COD In.	COD Ef.	ED In.	ED Ef.	Amm. In.	Amm. Ef.
624	234.0	95.9	701	89	397.0	0	0	119.0
630	234.0	92.8	701	103	397.0	0	0	124.0
648	234.0	76.6	701	53	397.0	0	0	127.8
672	240.0	76.6	730	73	466.7	0	0	120.0
696	240.0	150.5	730	257	466.7	154.0	0	127.8
702	240.0	140.2	730	284	466.7	154.0	0	122.0
720	266.0	148.0	730	283	634.0	134.0	0	130.0
726	266.0	138.0	774	273	634.0	121.0	0	124.0
744	266.0	118.7	774	54	634.0	0	0	110.0
768	266.0	95.4	774	49	634.0	0	0	136.0
774	266.0	140.0	774	61	634.0	0	0	136.0
792	266.0	168.9	774	185	634.0	0	0	136.0
798	266.0	146.0	774	42	634.0	0	0	136.0
816	266.0	157.7	774	70	634.0	0	0	136.0
840	266.0	146.0	774	98	634.0	0	0	136.0
864	266.0	154.0	774	185	634.0	0	0	136.0
870	266.0	125.0	774	104	634.0	0	0	136.0
888	266.0	124.0	774	92	634.0	0	0	136.0
894	275.0	112.0	794	68	714.0	0	0	144.0
912	275.0	130.0	794	57	714.0	0	0	147.0
918	275.0	120.0	794	42	714.0	0	0	147.8

Time	NO_3^- In.	NO_3^- Ef.	NO_2^- In.	NO_2^- Ef.	SO_4^{2-} In.	SO_4^{2-} Ef.	PO_4^{3-} In.	PO_4^{3-} Ef.
0	2.9	1.8	0	0	148.9	89.9	0	1.9
24	2.9	1.8	0	0	148.9	89.3	0	1.9
32	2.9	1.8	0	0	148.9	89.3	0	1.9
48	4.0	2.5	0.9	0	74.5	101.8	1.8	0
54	4.0	3.3	0.9	0	74.5	88.1	1.8	2
60	4.0	1.8	0.9	0	74.5	131.1	1.8	1.9
72	2.5	3.8	0	0	137.4	98.9	0	2.1
78	2.5	1.2	0	0	137.4	117.9	0	2.4
84	2.5	1.5	0	0	137.4	122.3	0	2.1
96	14.9	0.7	12.2	0	97.4	196.9	0	2.2
102	14.9	14.6	12.2	10.2	97.4	196.9	0	2.2
108	14.9	14.6	12.2	10.2	97.4	146.6	0	2.1
120	10.2	10.9	13.3	12.8	103.9	142.3	0	2.2
126	10.2	10.8	13.3	7.8	103.9	137.3	0	2.2
132	10.2	10.5	13.3	6.5	103.9	149.4	0	3.4
144	4.4	8.1	3.2	5.9	140.7	116.7	2.5	2.4
168	5.2	5.1	2.1	0	138.3	125.0	1.8	2.4
192	5.5	4.8	1.8	0.7	100.1	138.7	1.9	2.1
198	5.5	3.8	1.8	0	100.1	148.3	1.9	8.3
216	5.5	3.4	1.8	0	100.1	114.3	1.9	3.6
222	7.7	6.8	4.4	0	175.8	142.8	7.9	10.3
240	7.7	6.1	4.4	0	175.8	172.5	7.9	8.7
264	7.7	6.9	4.4	0	175.8	202.6	7.9	9.4
264	4.6	5.1	5.8	3.7	262.1	202.6	8.4	9.4
270	4.6	4.7	5.8	0	227.1	227.1	8.3	8.3
288	4.6	5.5	5.8	0	227.1	271.2	8.3	8.5

Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
60	9.8	0.05	NT	NT	NT	NT	NT
72	9.7	0.09	3070	115	95	85	30.9
78	9.6	0.04	2170	112	90	85	41.5
84	9.1	0.05	NT	NT	NT	NT	NT
96	9.6	0.16	2850	120	90	80	31.6
102	8.9	0.12	2010	70	60	55	29.9
108	9.6	0.08	NT	NT	NT	NT	NT
120	9.2	0.12	2530	70	60	60	23.7
126	9.5	0.19	3110	160	130	120	41.8
132	9.3	0.15	NT	NT	NT	NT	NT
144	9.0	0.11	2830	135	110	100	38.9
168	10.4	0.10	2540	90	75	70	29.5
192	10.4	0.09	2570	110	90	80	35.0
198	9.4	0.09	2270	95	80	75	35.2
216	9.3	0.17	5160	260	210	185	40.7
222	8.8	0.22	4940	255	205	180	41.4
240	9.3	0.16	4900	270	215	190	43.8
264	9.0	0.19	5330	290	230	205	43.1
264	8.8	0.47	3700	150	120	110	32.4
270	7.2	0.39	1590	95	80	75	50.3
288	9.1	0.27	6430	270	215	190	33.4
294	9.1	0.18	3850	145	120	110	31.2
312	9.7	0.22	3430	135	110	100	32.1
318	8.2	0.29	3690	120	100	90	27.1
336	9.1	0.15	3220	125	105	95	32.6
360	9.5	0.11	3430	140	110	105	32.0
360	9.3	0.11	3180	110	90	85	28.3
384	9.3	0.12	2840	100	85	80	29.9
390	9.5	0.24	3090	125	105	95	34.0
408	9.1	0.15	2240	75	65	60	29.0
414	8.6	0.14	1600	60	55	50	34.3
432	8.2	0.16	2390	50	45	40	18.8
438	7.8	0.08	2840	80	75	70	26.4
456	7.9	0.20	4530	195	160	145	35.2
462	8.4	0.24	4580	205	170	150	37.1
480	8.8	0.21	3420	160	145	125	42.4
504	9.1	0.16	2980	140	120	110	40.3
528	9.3	0.30	3000	135	115	105	38.3
552	10.4	0.24	2910	130	110	100	37.8
576	9.0	0.57	3510	160	135	120	38.4
600	8.8	0.15	3710	140	120	110	32.3
606	10.2	0.07	3500	140	120	110	34.2
624	8.8	0.17	4100	165	140	120	34.1
630	8.9	0.15	3500	140	120	105	34.3
648	8.6	0.11	3070	145	120	110	39.1
672	8.4	0.45	1760	85	70	65	39.8
696	8.9	0.51	1930	60	50	50	25.9
702	9.5	0.49	1820	50	45	45	24.7
720	8.6	0.47	1800	130	105	95	58.3
726	8.1	1.40	2710	140	120	110	44.3
744	8.0	0.27	2910	160	130	120	44.7

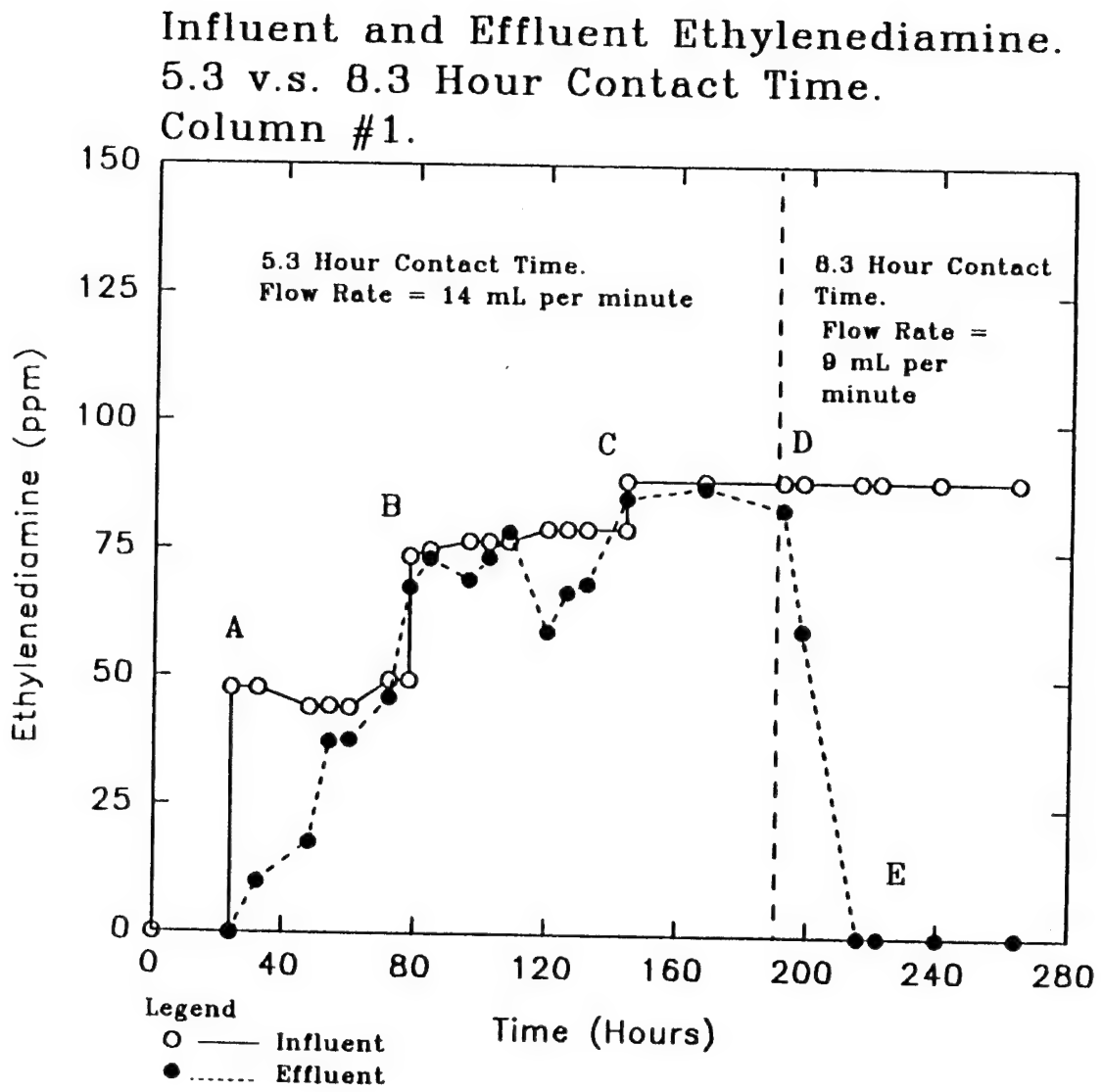
Time	DO	SOUR	MLSS	SSV 15	SSV 30	SSV 45	SVI
768	7.7	0.15	2860	160	130	115	45.5
774	6.7	0.29	2870	140	120	100	41.8
792	6.9	0.44	3210	160	130	120	39.3
798	7.7	0.36	3270	150	130	115	39.8
816	9.4	0.16	3340	160	130	120	38.9
840	8.4	0.25	2880	150	120	110	41.7
864	9.3	0.56	2780	150	120	110	43.2
870	9.5	0.89	2510	140	115	105	45.8
888	6.7	0.04	2530	140	115	100	45.4
894	6.8	0.66	2660	140	120	110	45.1
912	6.8	0.75	2640	160	130	120	49.2
918	7.2	1.00	2830	130	110	100	38.8

Time	pH In.	pH Bioreact.	pH Ef.
0	8.5	8.3	8.2
24	8.5	8.3	8.2
32	8.5	7.4	8.2
48	8.5	8.2	NT
54	8.5	8.2	8.2
60	8.5	8.3	8.1
72	8.5	8.4	8.3
78	8.5	8.3	8.3
84	NT	NT	NT
96	8.5	8.5	8.4
102	8.5	8.4	8.4
108	NT	NT	NT
120	8.5	7.8	8.0
126	8.5	8.9	8.3
132	NT	NT	NT
144	8.5	8.5	8.6
168	8.5	8.6	8.6
192	8.5	8.5	8.3
198	8.5	8.3	8.3
216	8.5	8.3	8.1
222	8.5	8.2	8.0
240	8.5	8.3	8.3
264	8.5	8.3	8.2
264	8.5	8.5	8.4
270	8.5	8.4	8.3
288	8.5	8.5	8.4
294	8.5	8.4	8.4
312	8.5	8.5	8.3
318	8.5	8.4	8.4
336	8.5	8.4	8.3
360	8.5	8.4	8.3
366	8.5	8.4	8.3
384	8.5	8.4	8.5
390	8.5	8.4	8.3
408	8.5	8.2	8.3
414	8.5	8.2	8.1

Time	pH In.	pH Bioreact.	pH Ef.
432	8.5	8.2	8.2
438	8.5	8.2	8.1
456	8.5	8.3	8.3
462	8.5	8.2	8.2
480	8.5	8.3	8.4
504	8.5	8.3	8.3
528	8.5	8.4	8.4
552	8.5	8.4	8.3
576	8.5	8.3	8.4
600	8.5	8.2	8.2
606	8.5	8.4	8.3
624	8.5	8.3	8.4
630	8.5	8.3	8.2
648	8.5	8.3	8.3
672	8.5	8.4	8.4
696	8.5	8.4	8.4
702	8.5	8.3	8.3
720	8.5	8.4	8.4
726	8.5	8.2	8.2
744	8.5	8.4	8.4
768	8.5	8.3	8.4
774	8.5	8.3	8.3
792	8.5	8.4	8.3
798	8.5	8.3	8.3
816	8.5	8.4	8.3
840	8.5	8.2	8.3
864	8.5	8.2	8.3
870	8.5	8.2	8.2
888	8.5	8.2	8.2
894	8.5	8.2	8.1
912	8.5	8.3	8.2
918	8.5	8.3	8.2

APPENDIX J

GRAPHICAL PRESENTATION OF BIOREACTOR TEST DATA



EVENTS:

A. At 24 hours the influent was spiked with 47.8 ppm ethylenediamine. Ethylenediamine was detected in the effluent at 32 hours.

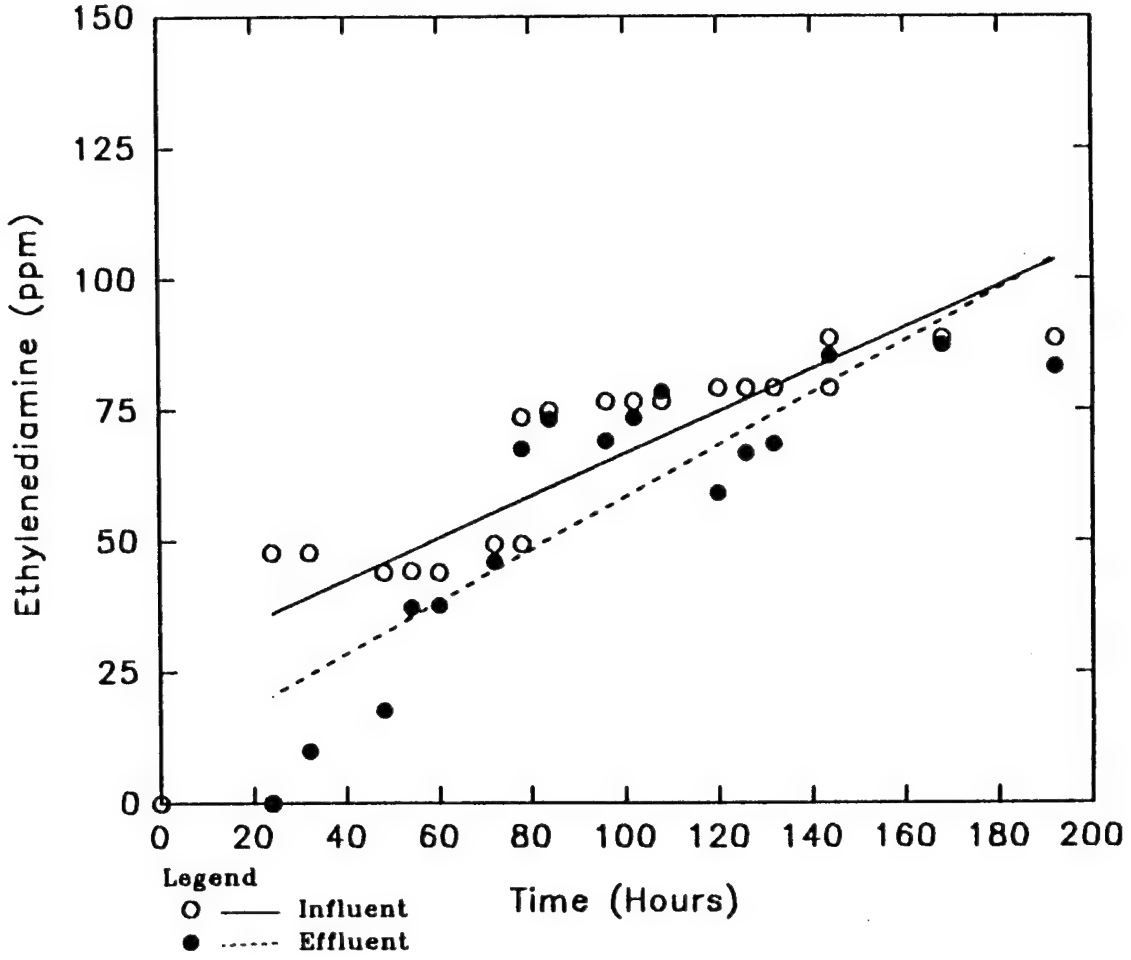
B. At 78 hours the influent ethylenediamine was increased to 73.6 ppm.

C. At 144 hours the influent ethylenediamine was increased to 88.7 ppm.

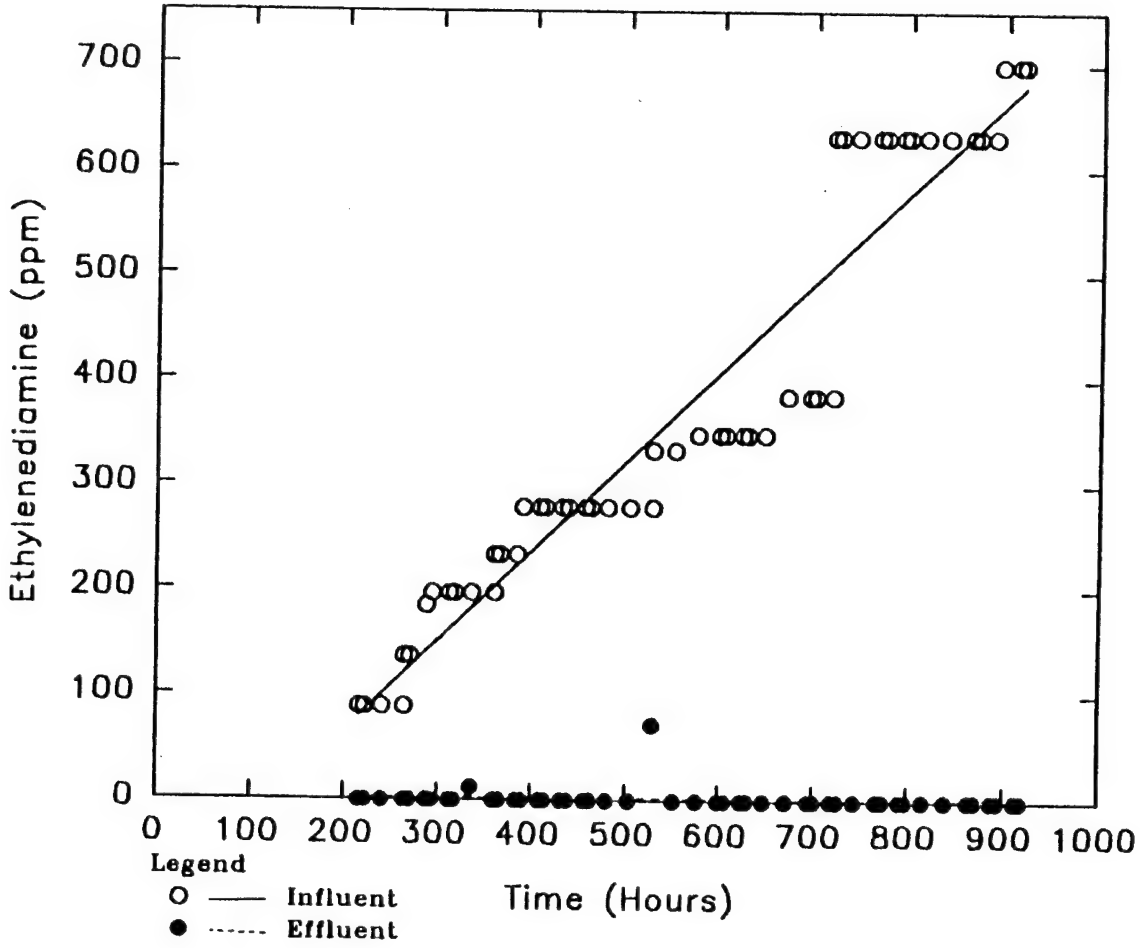
D. At 192 hours the influent flow rate was decreased from 14 mL per minute to 9 mL per minute. This changed to contact time from 5.3 hours to 8.3 hours.

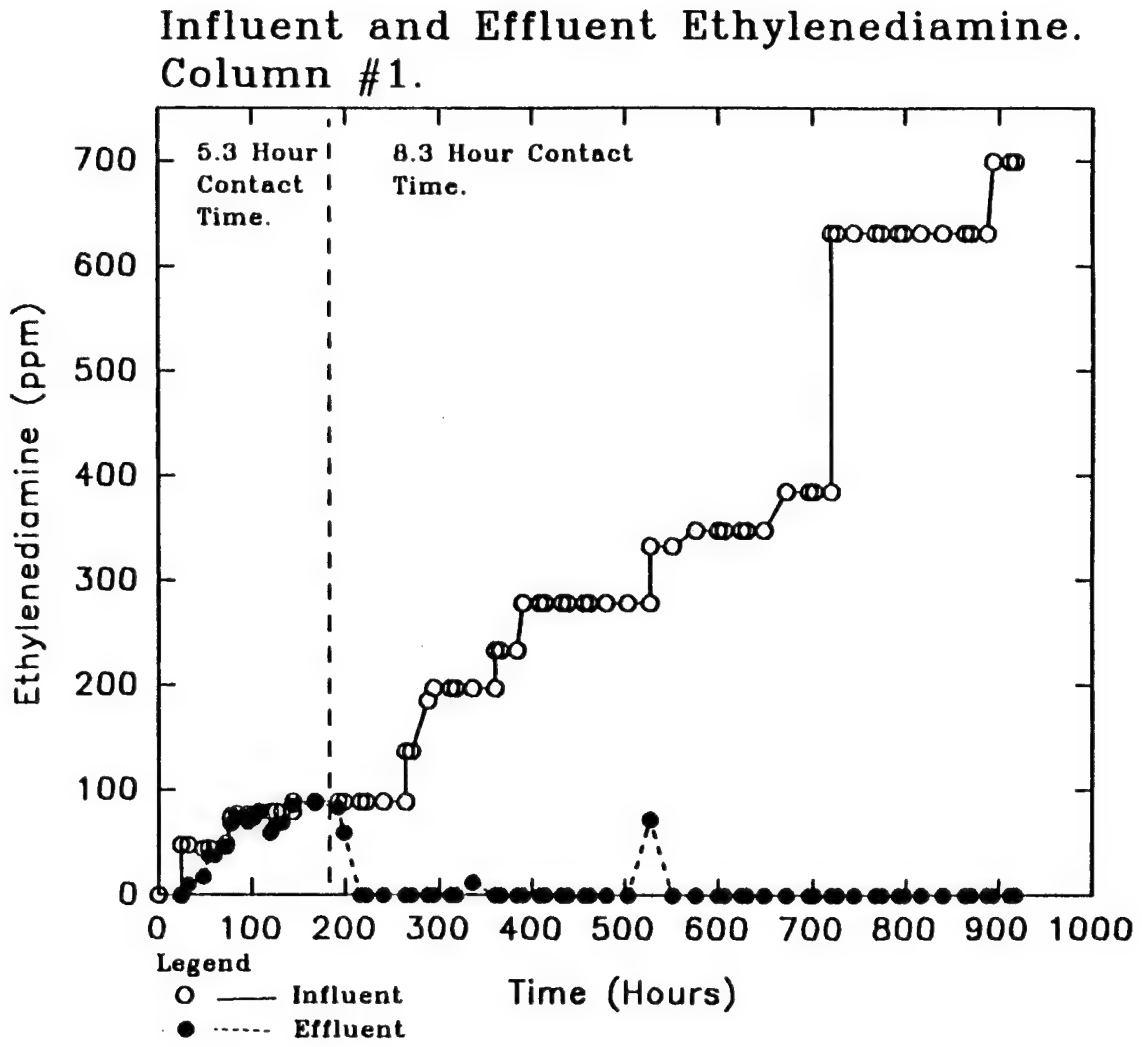
E. After increasing the contact time, ethylenediamine was removed within 24 hours.

Influent and Effluent Ethylenediamine.
5.3 Hour Contact Time.
Column #1.

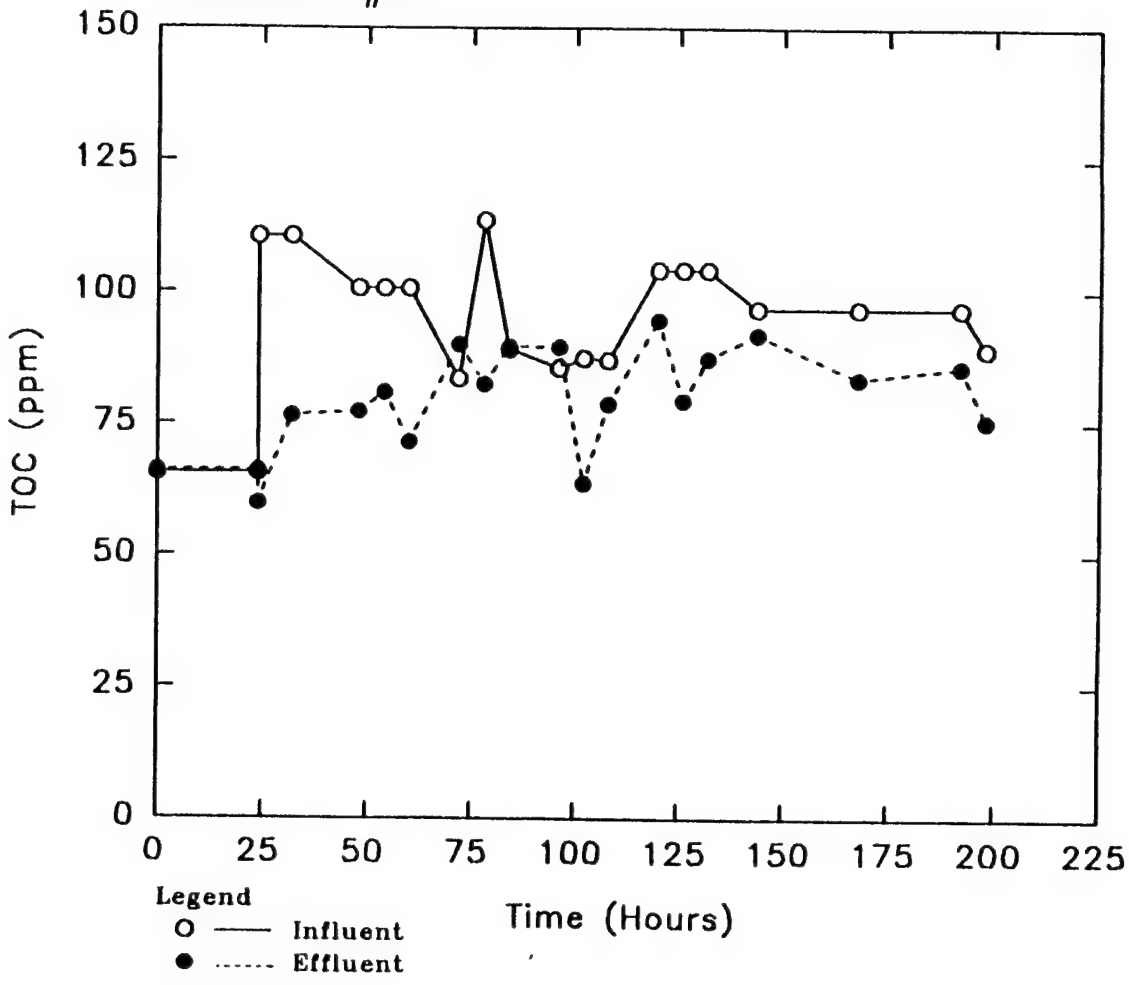


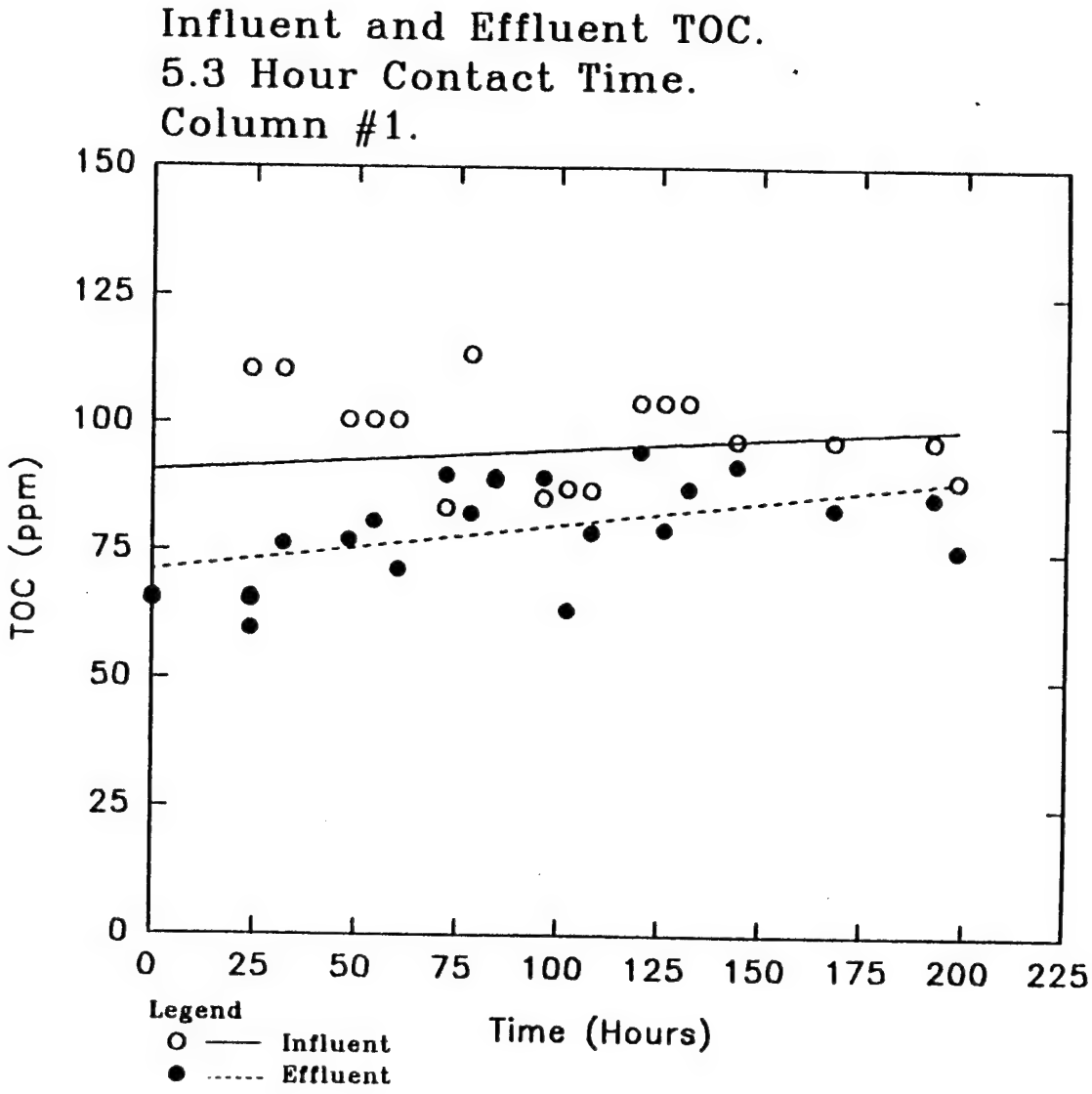
Influent and Effluent Ethylenediamine.
8.3 Hour Contact Time.
Column #1.

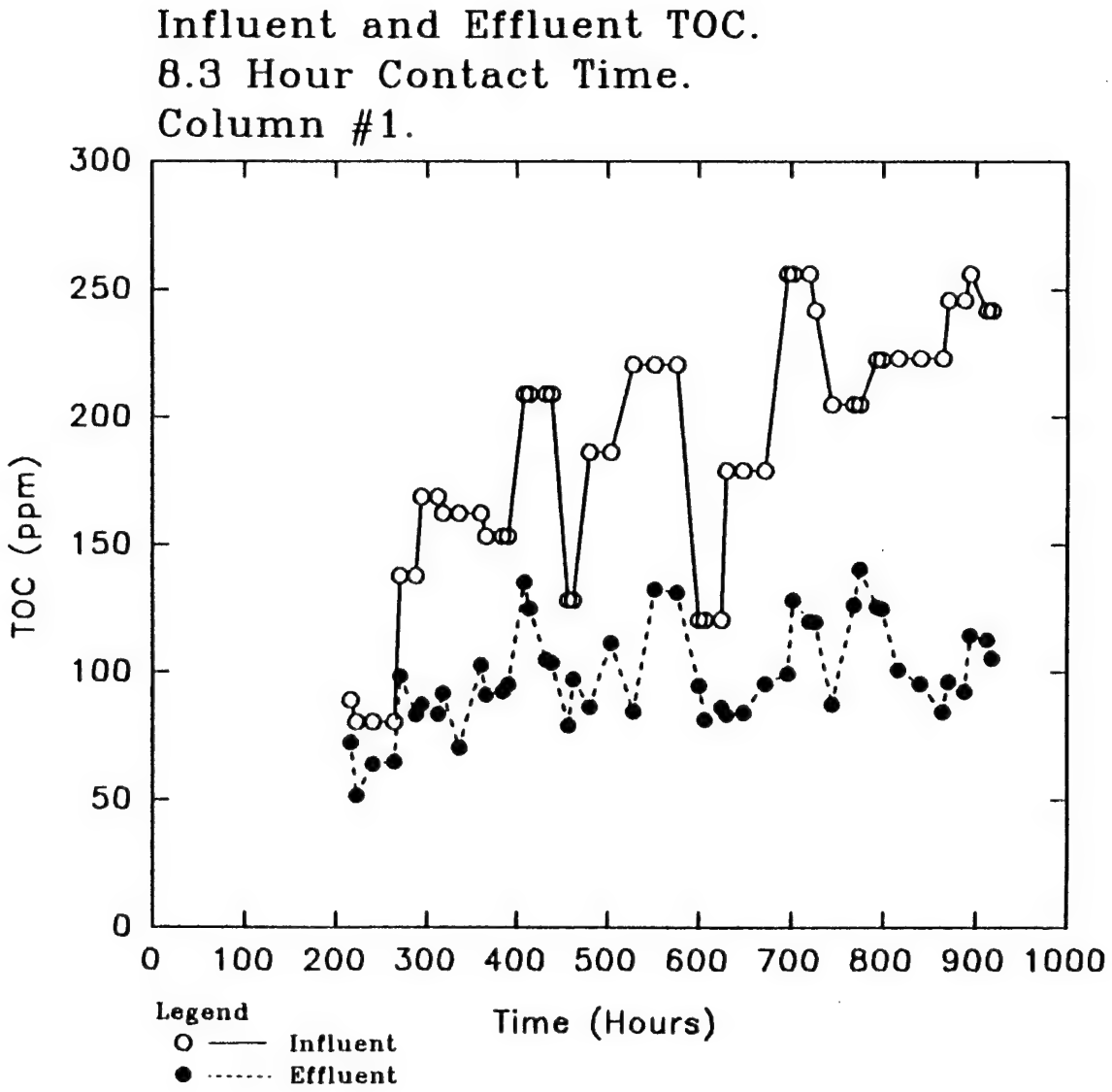


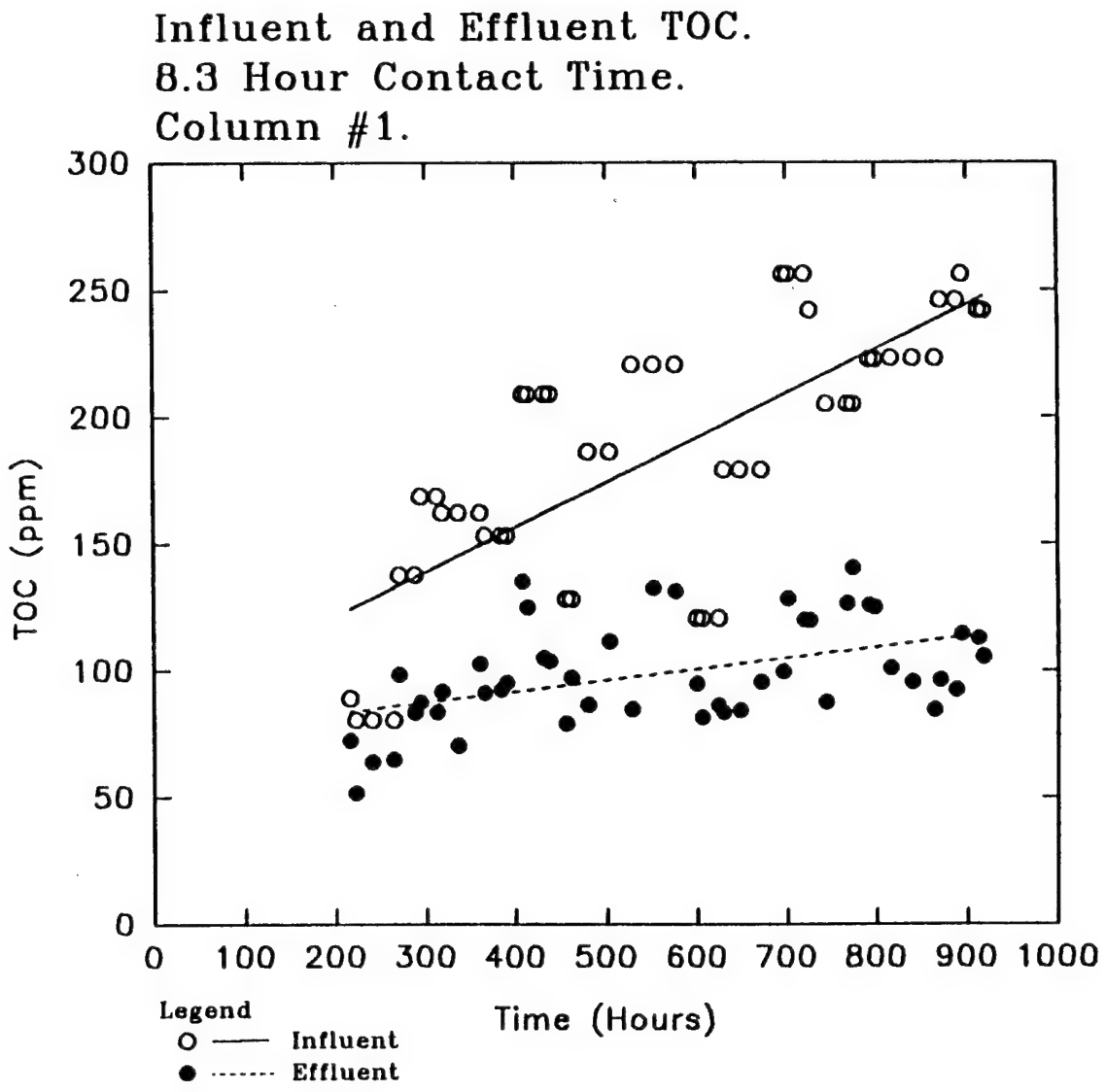

Influent and Effluent Ethylenediamine.
Column #1.
5.3 Hour Contact Time.
8.3 Hour Contact Time.
Ethylenediamine (ppm)
0
100
200
300
400
500
600
700
0
100
200
300
400
500
600
700
800
900
1000
Time (Hours)
Legend
Influent
Effluent

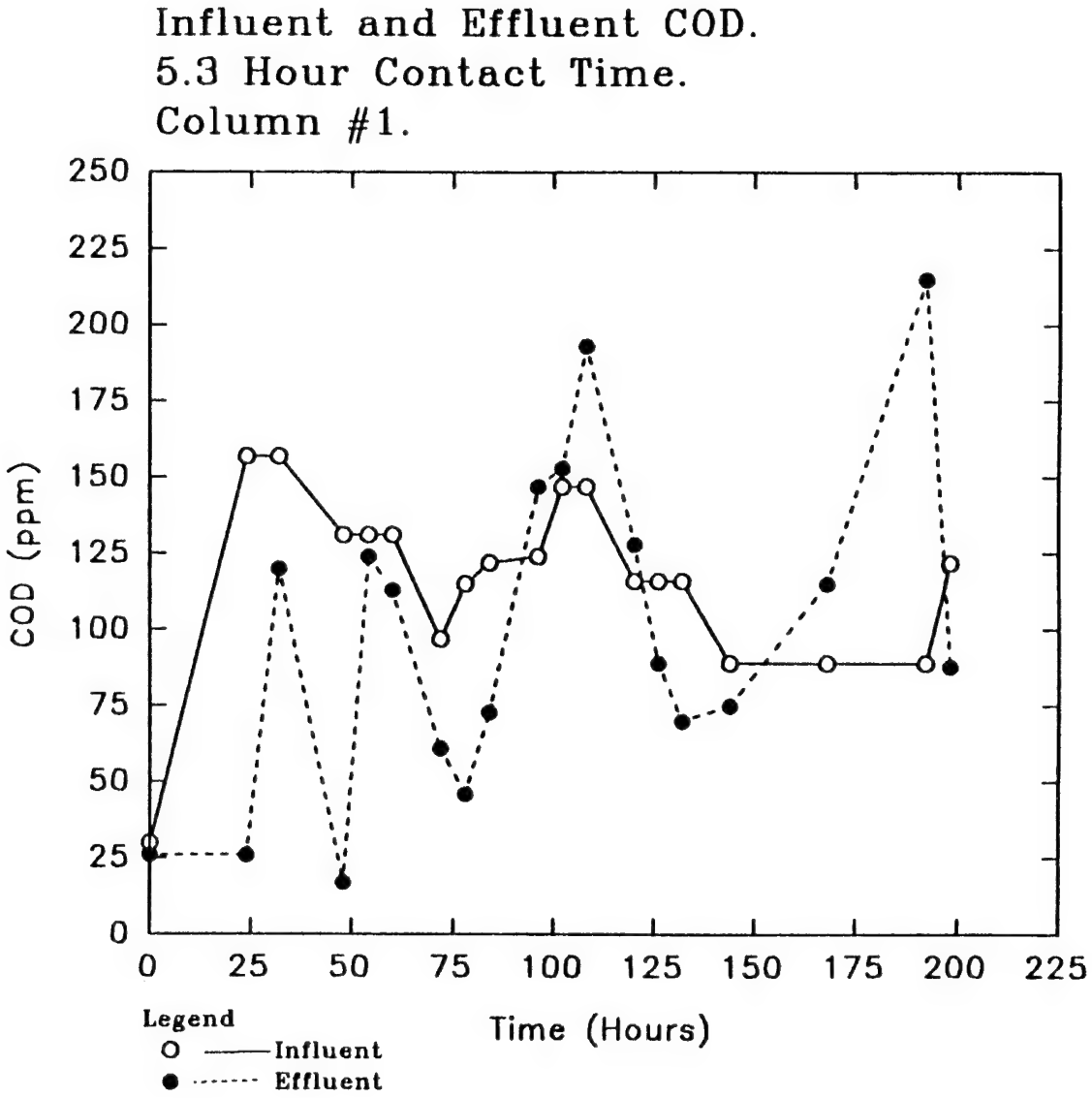
Influent and Effluent TOC.
5.3 Hour Contact Time.
Column #1.



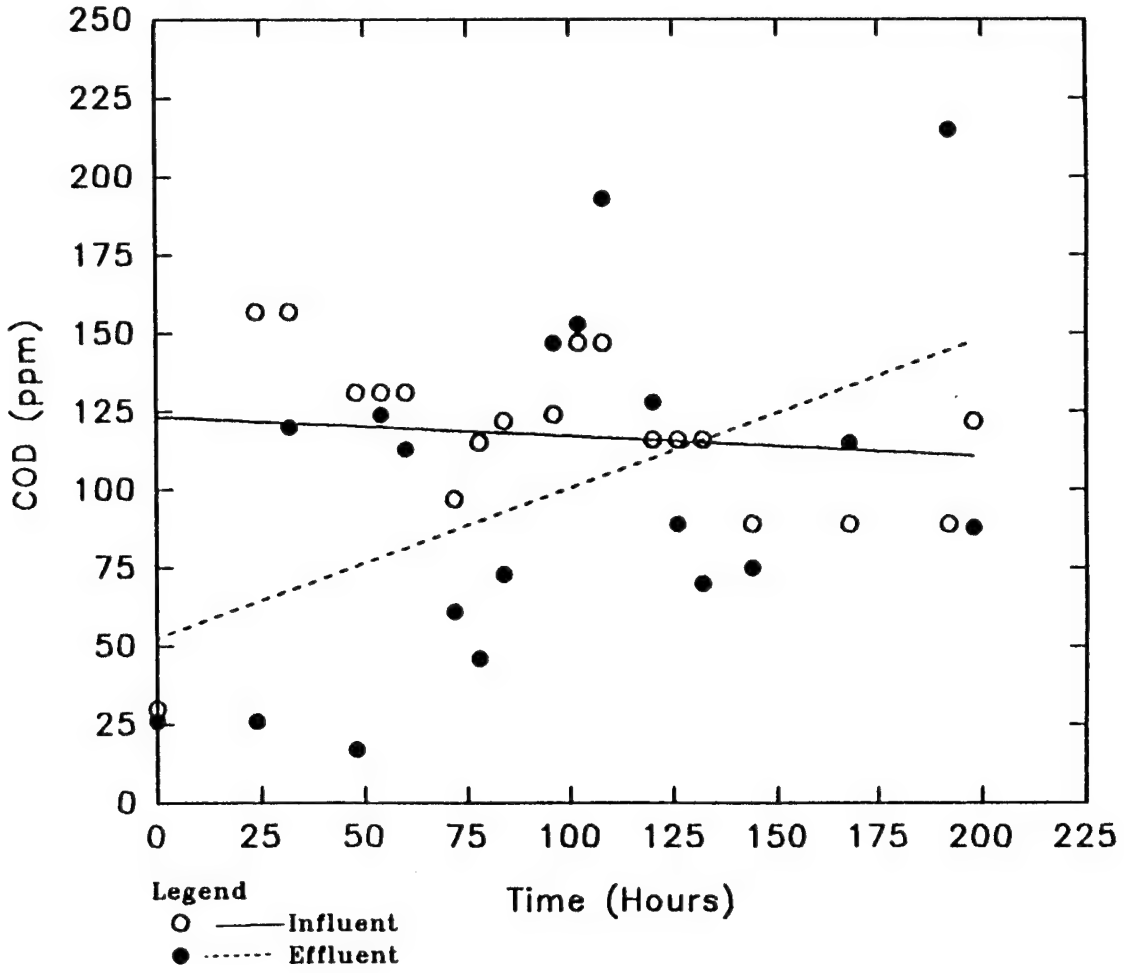

Influent and Effluent TOC.
5.3 Hour Contact Time.
Column #1.
TOC (ppm)
150
125
100
75
50
25
0
0
25
50
75
100
125
150
175
200
225
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent TOC.
8.3 Hour Contact Time.
Column #1.
TOC (ppm)
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
1000
Time (Hours)
Legend
Influent
Effluent

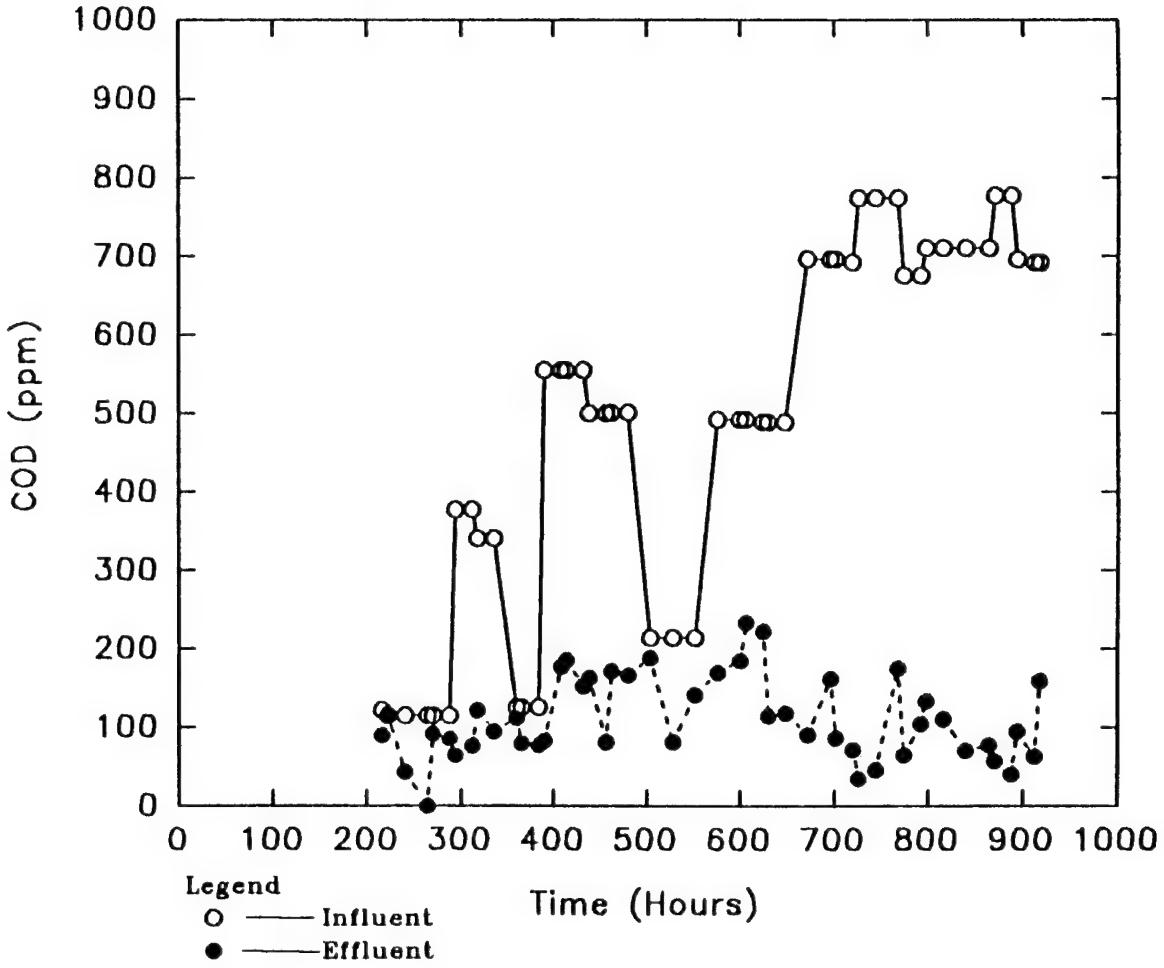

Influent and Effluent TOC.
8.3 Hour Contact Time.
Column #1.
TOC (ppm)
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
1000
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent COD.
5.3 Hour Contact Time.
Column #1.
COD (ppm)
250
225
200
175
150
125
100
75
50
25
0
0
25
50
75
100
125
150
175
200
225
Time (Hours)
Legend
Influent
Effluent

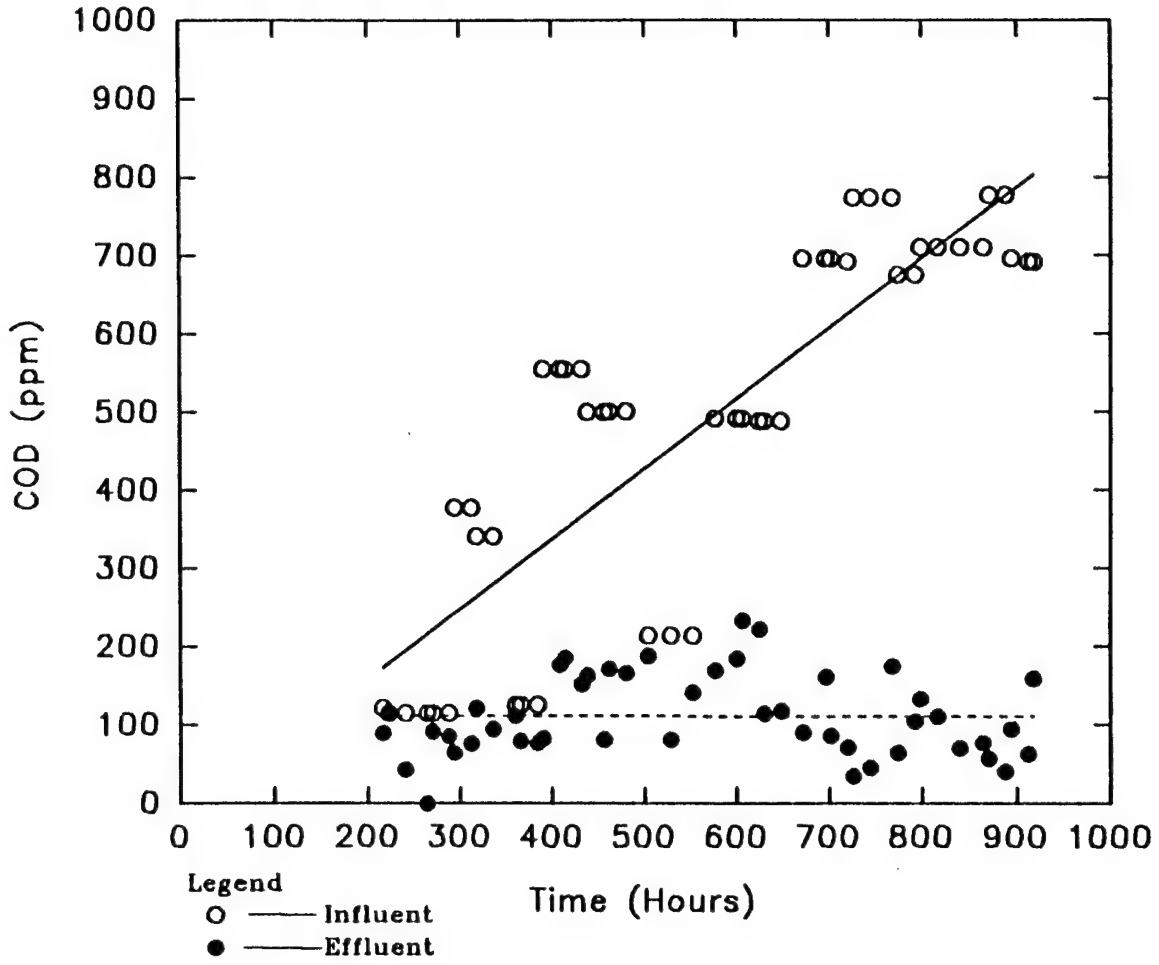
Influent and Effluent COD.
5.3 Hour Contact Time.
Column #1.



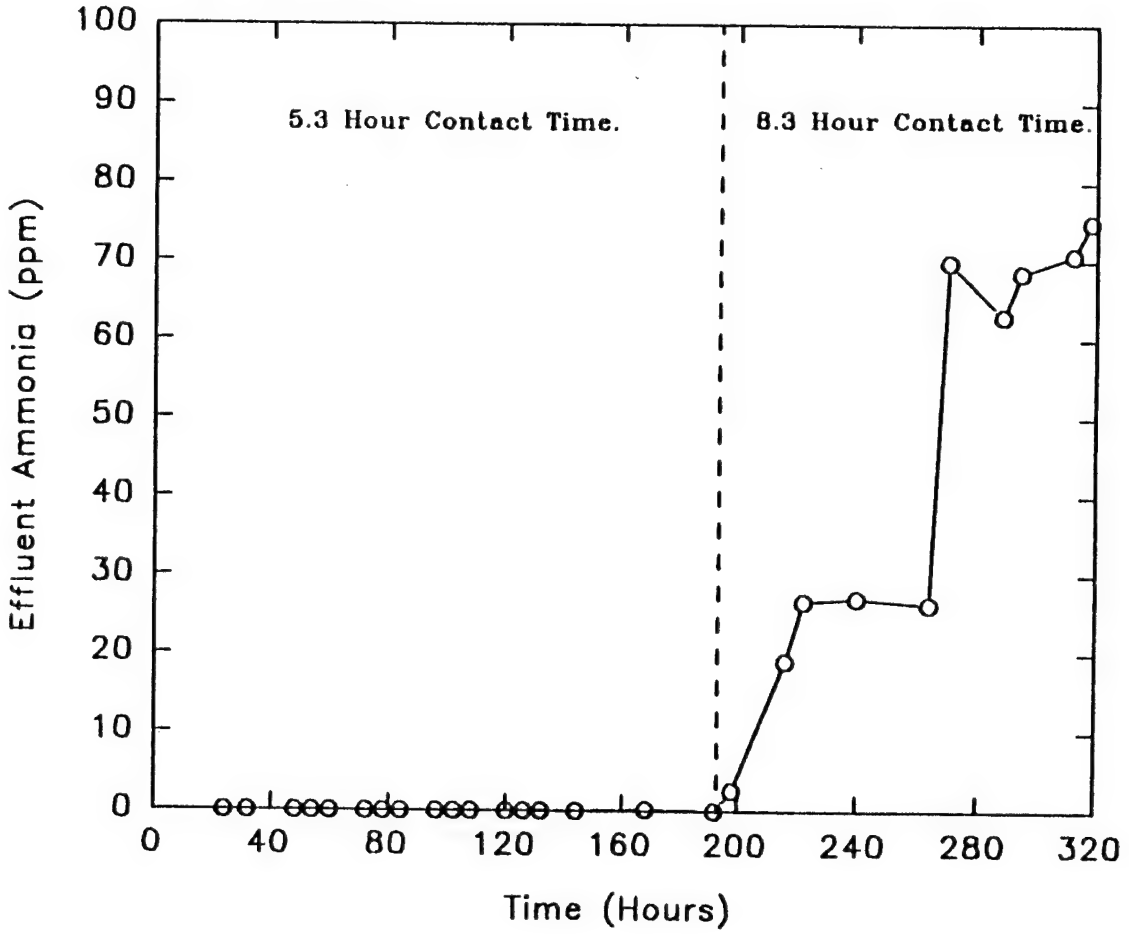
Influent and Effluent COD.
8.3 Hour Contact Time.
Column #1.

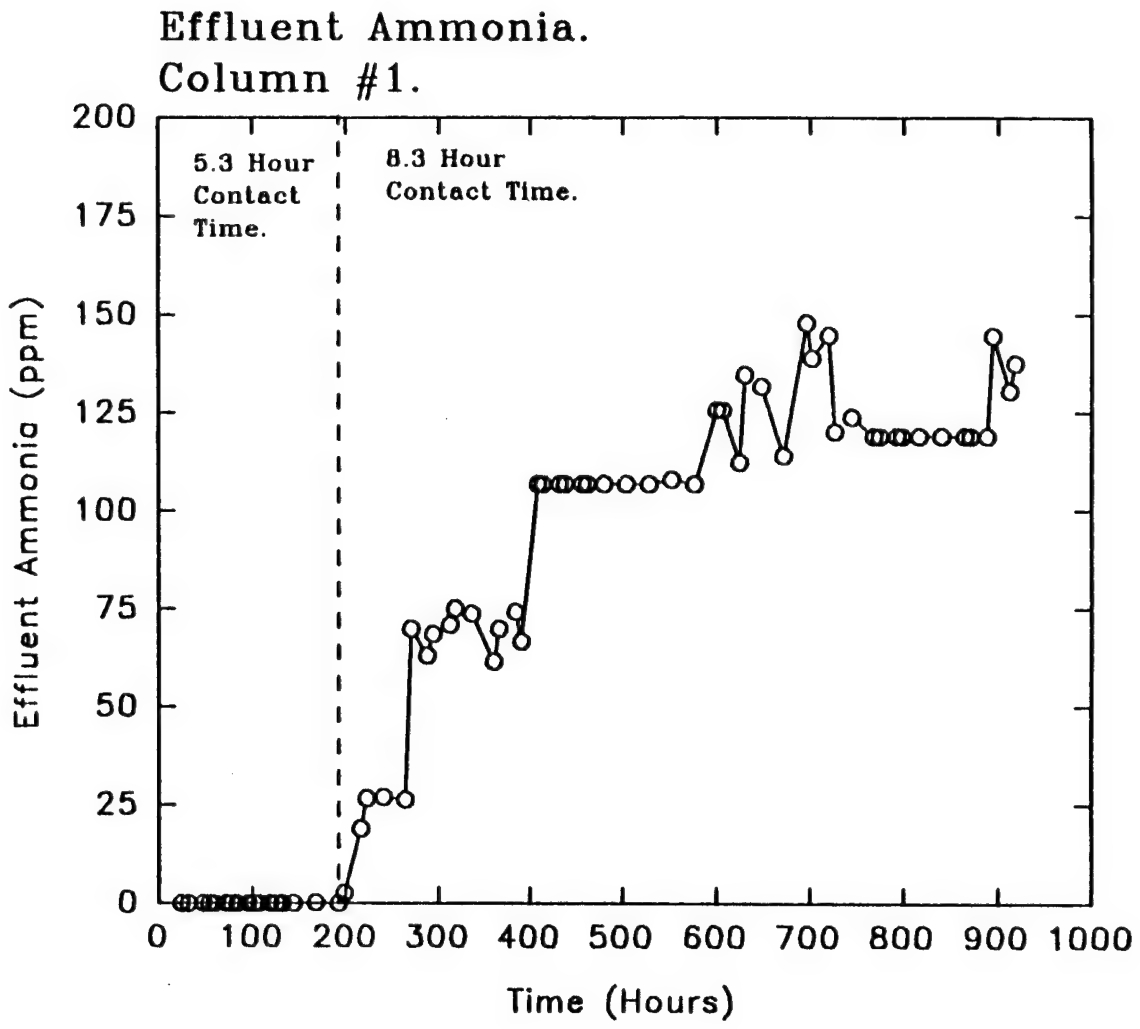


Influent and Effluent COD.
8.3 Hour Contact Time.
Column #1.

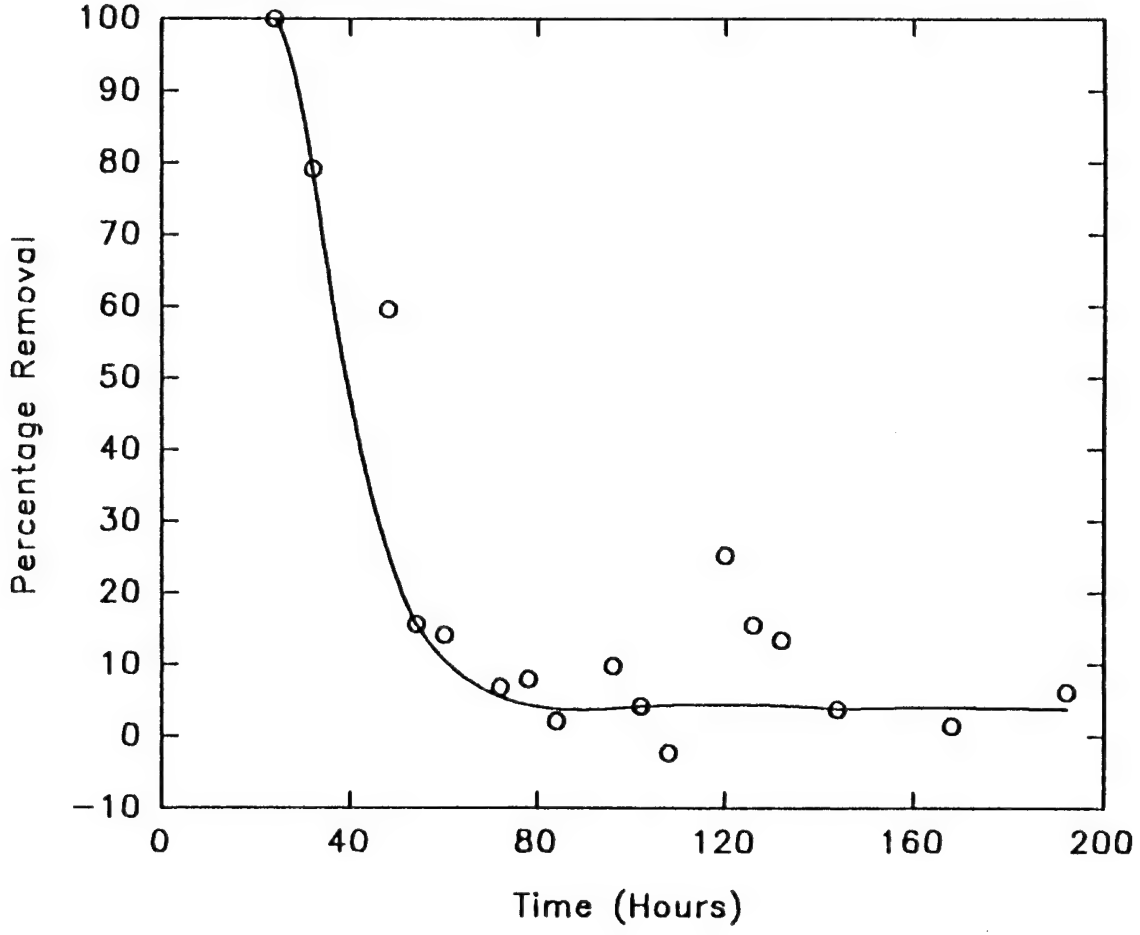


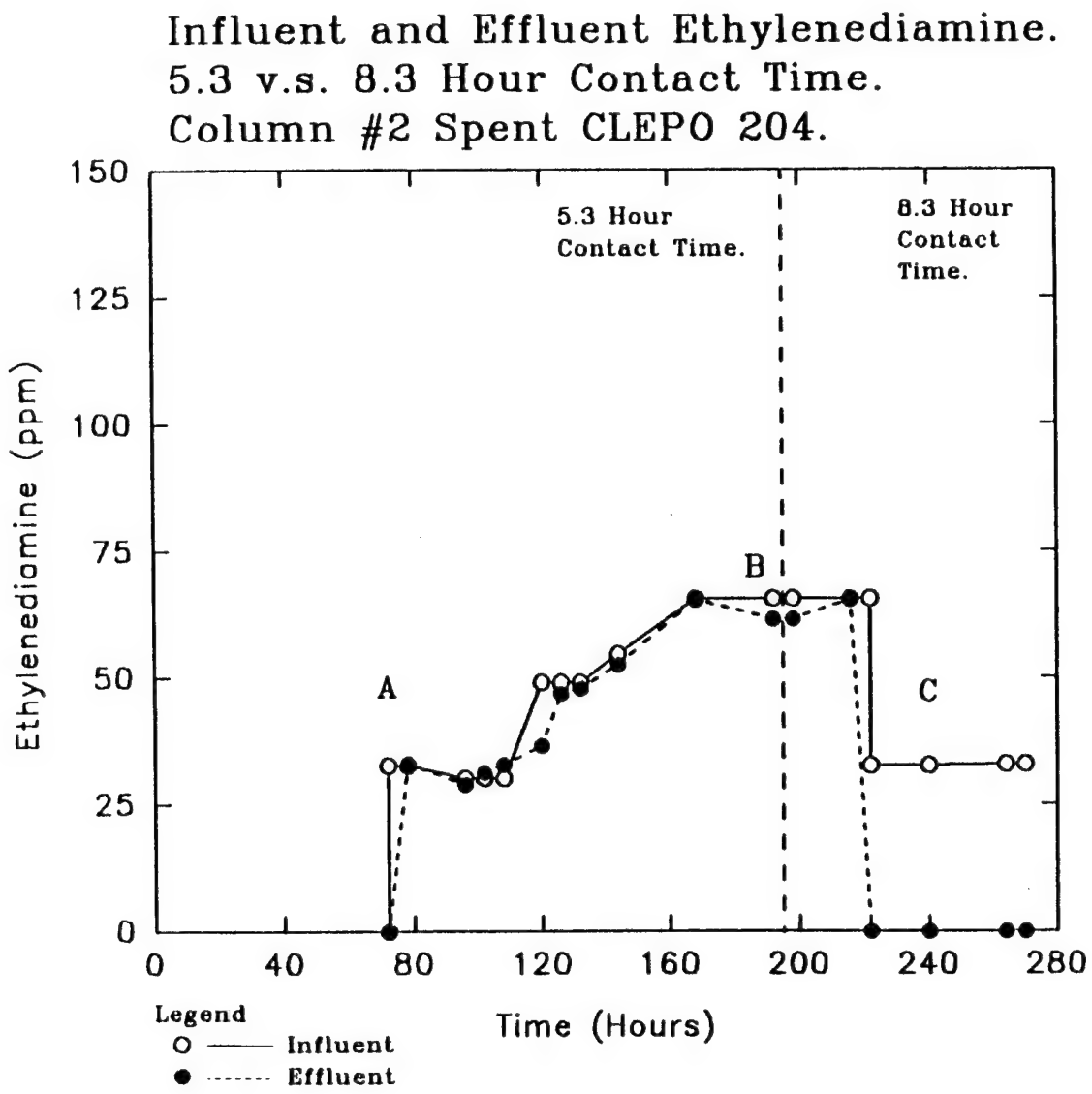
Effluent Ammonia.
5.3 v.s. 8.3 Hour Contact Time.
Column #1.




Effluent Ammonia.
Column #1.
5.3 Hour
Contact
Time.
8.3 Hour
Contact Time.
Effluent Ammonia (ppm)
200
175
150
125
100
75
50
25
0
0
100
200
300
400
500
600
700
800
900
1000
Time (Hours)

Percentage Removal of
Ethylenediamine.
5.3 Hour Contact Time.
Column #1.



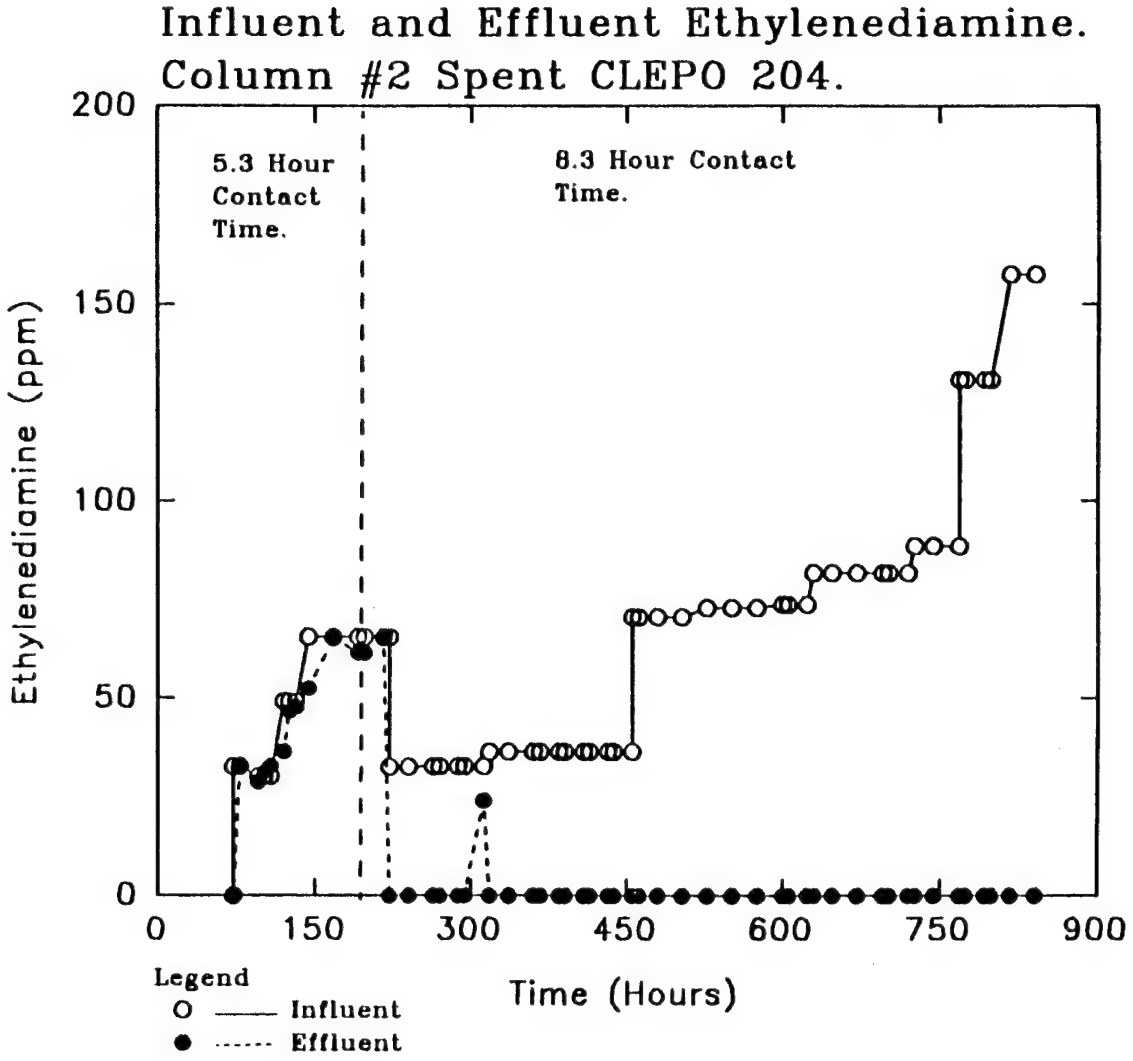


EVENTS:

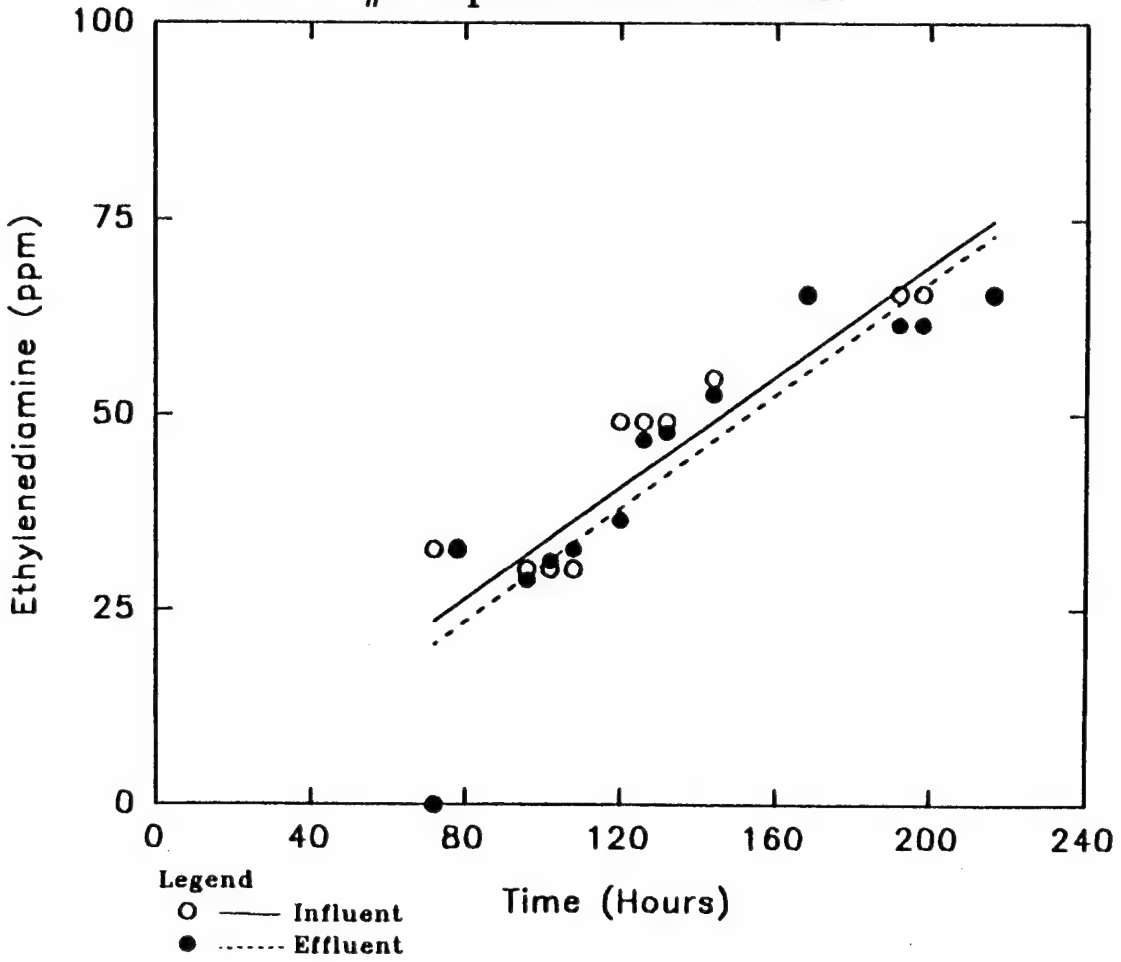
A. At 72 hours the influent was spiked with a spent CLEPO 204 solution. The ethylenediamine concentration was 32.7 ppm.

B. At 192 hours the influent flow rate was decreased from 14 mL per minute to 9 mL per minute. This changed the contact time from 5.3 hours to 8.3 hours.

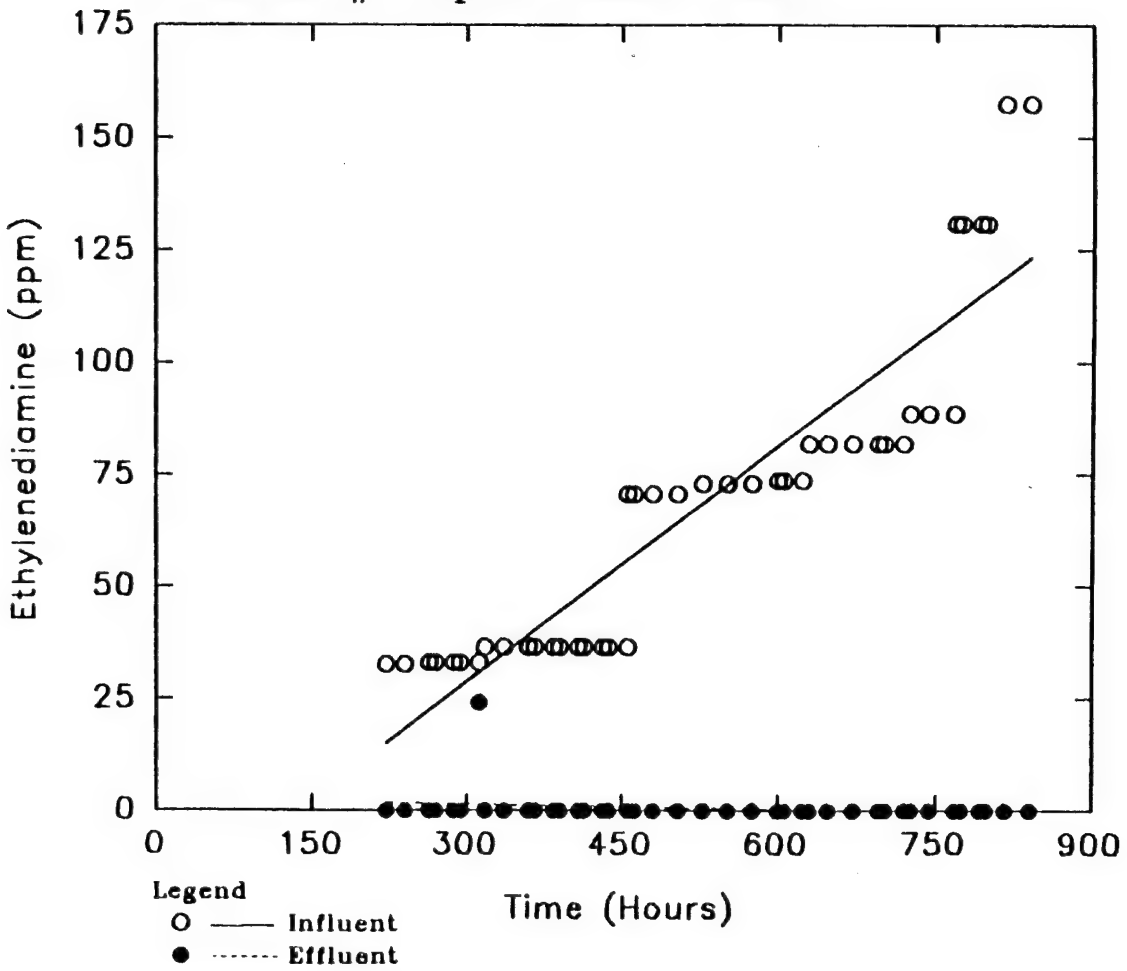
C. At 222 hours (30 hours after the influent flow rate adjustment) no ethylenediamine could be detected in the effluent.

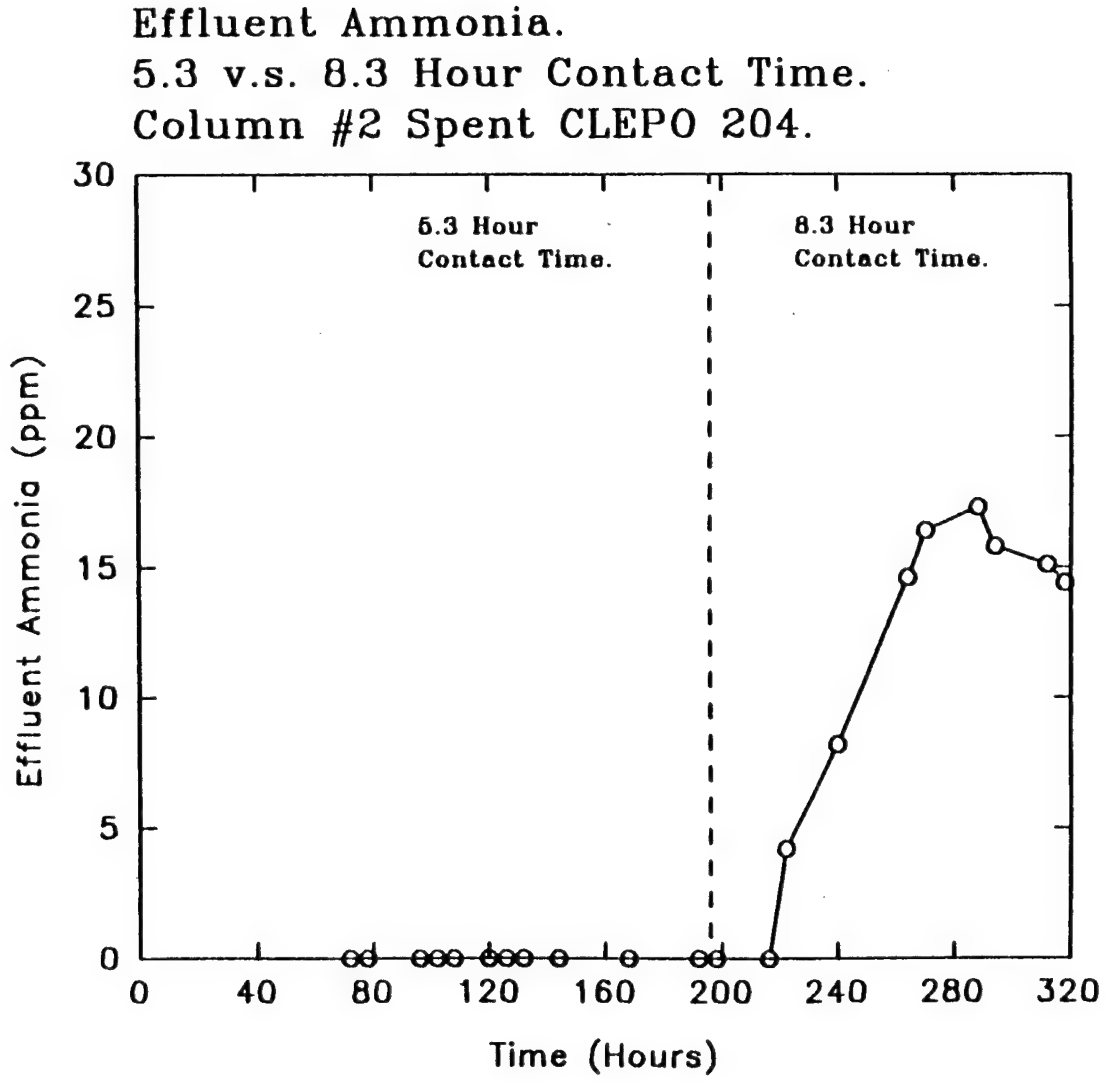

Influent and Effluent Ethylenediamine.
Column #2 Spent CLEPO 204.
5.3 Hour Contact Time.
8.3 Hour Contact Time.
Ethylenediamine (ppm)
200
150
100
50
0
0
150
300
450
600
750
900
Time (Hours)
Legend
Influent
Effluent

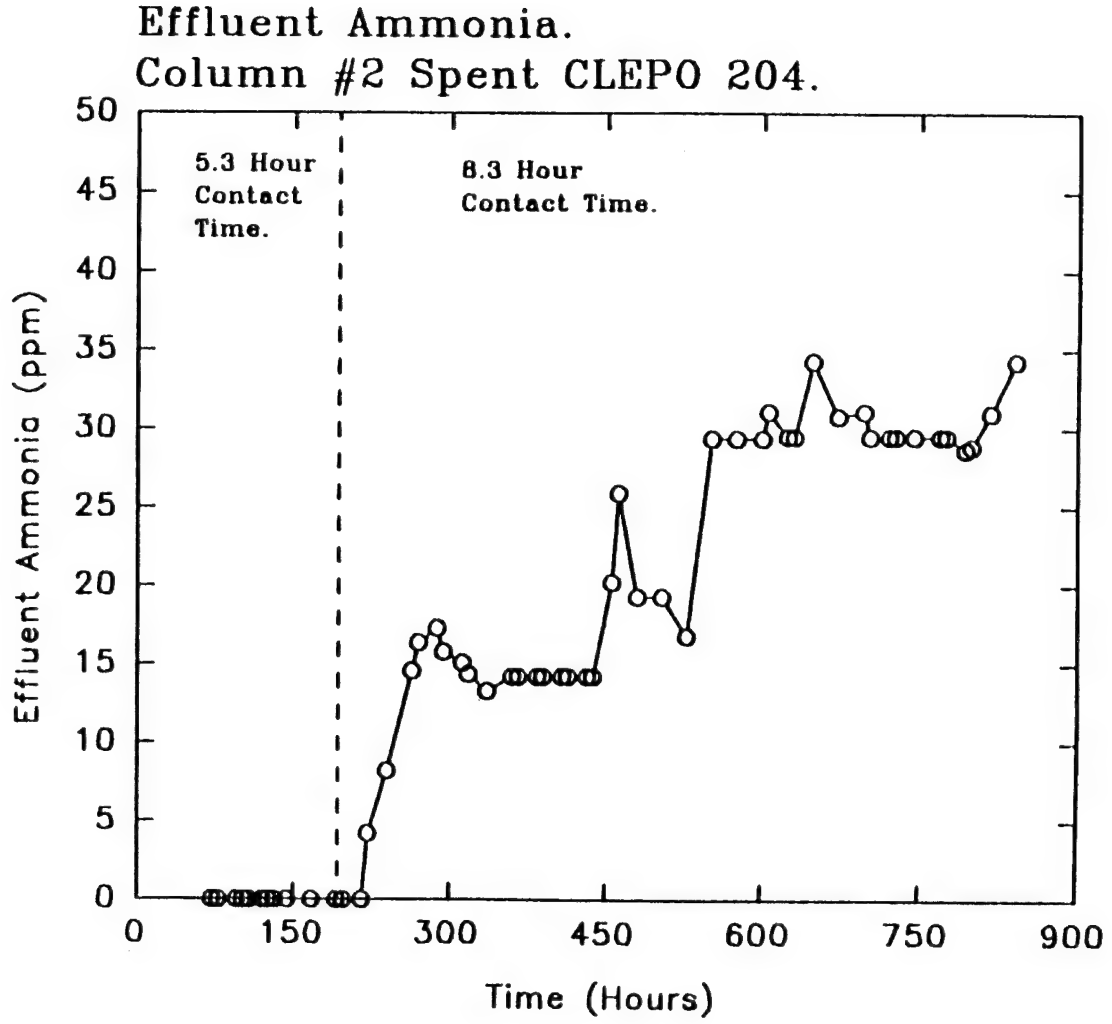
Influent and Effluent Ethylenediamine.
5.3 Hour Contact Time.
Column #2 Spent CLEPO 204.

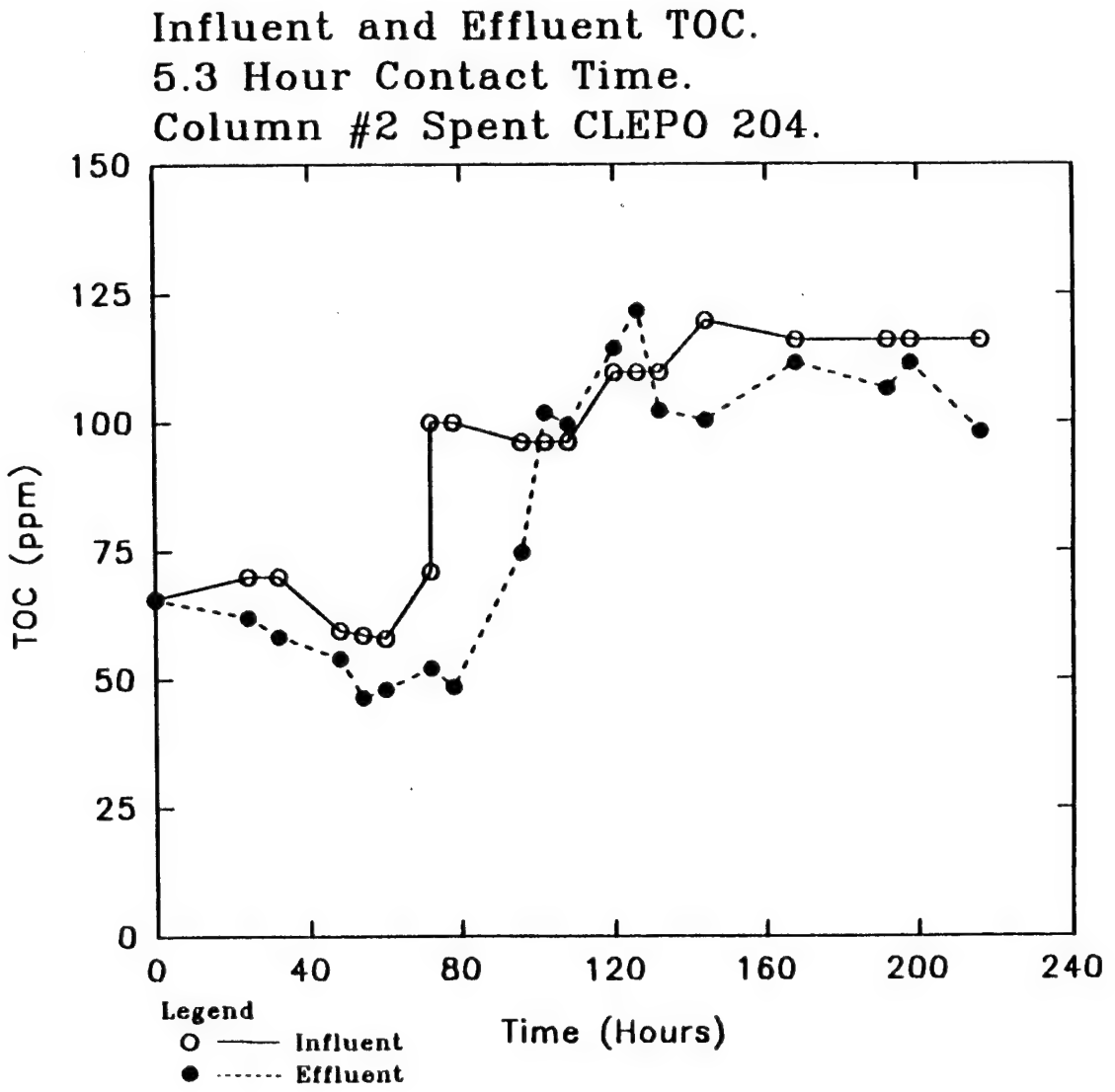


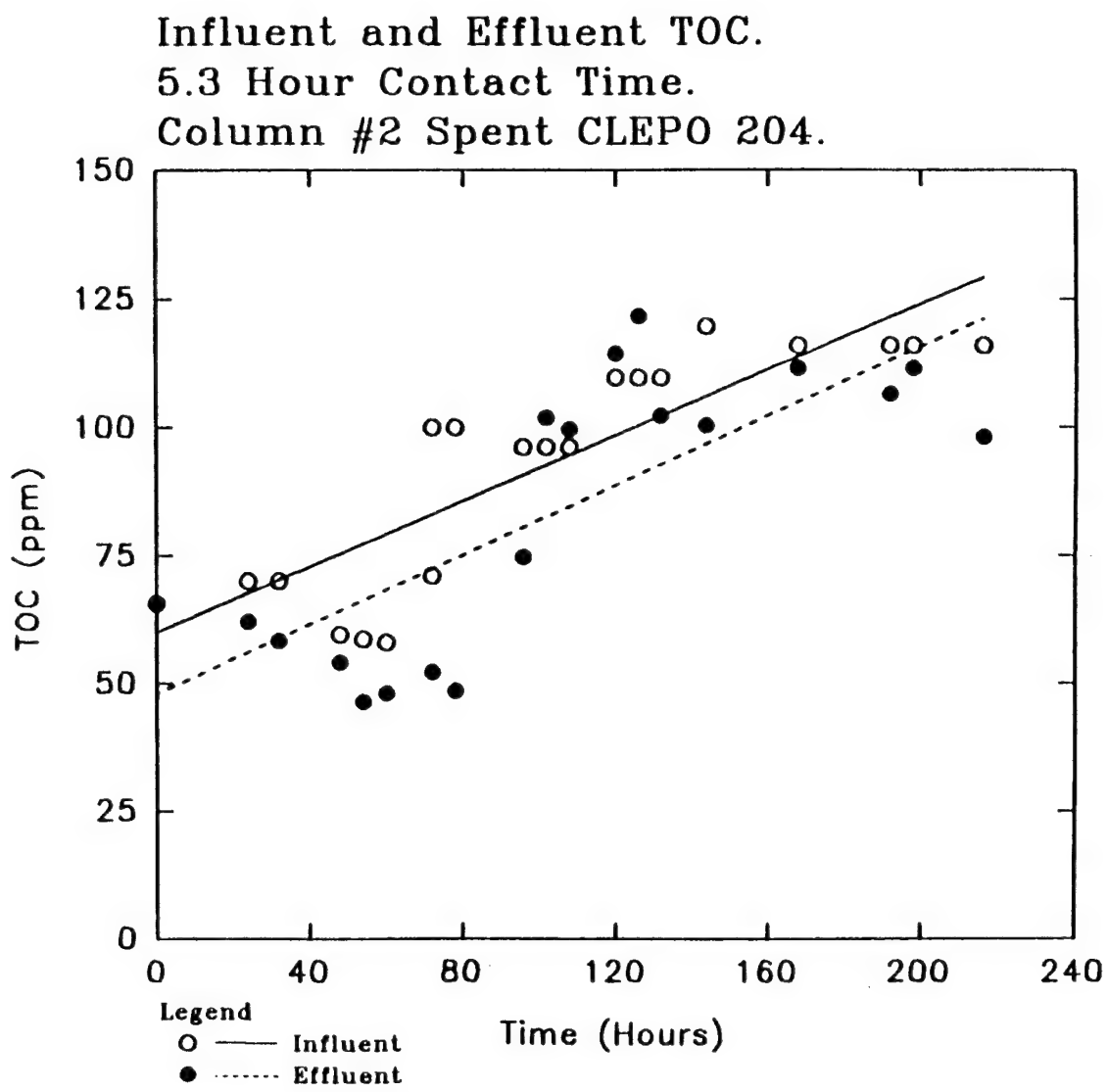
Influent and Effluent Ethylenediamine.
8.3 Hour Contact Time.
Column #2 Spent CLEPO 204.

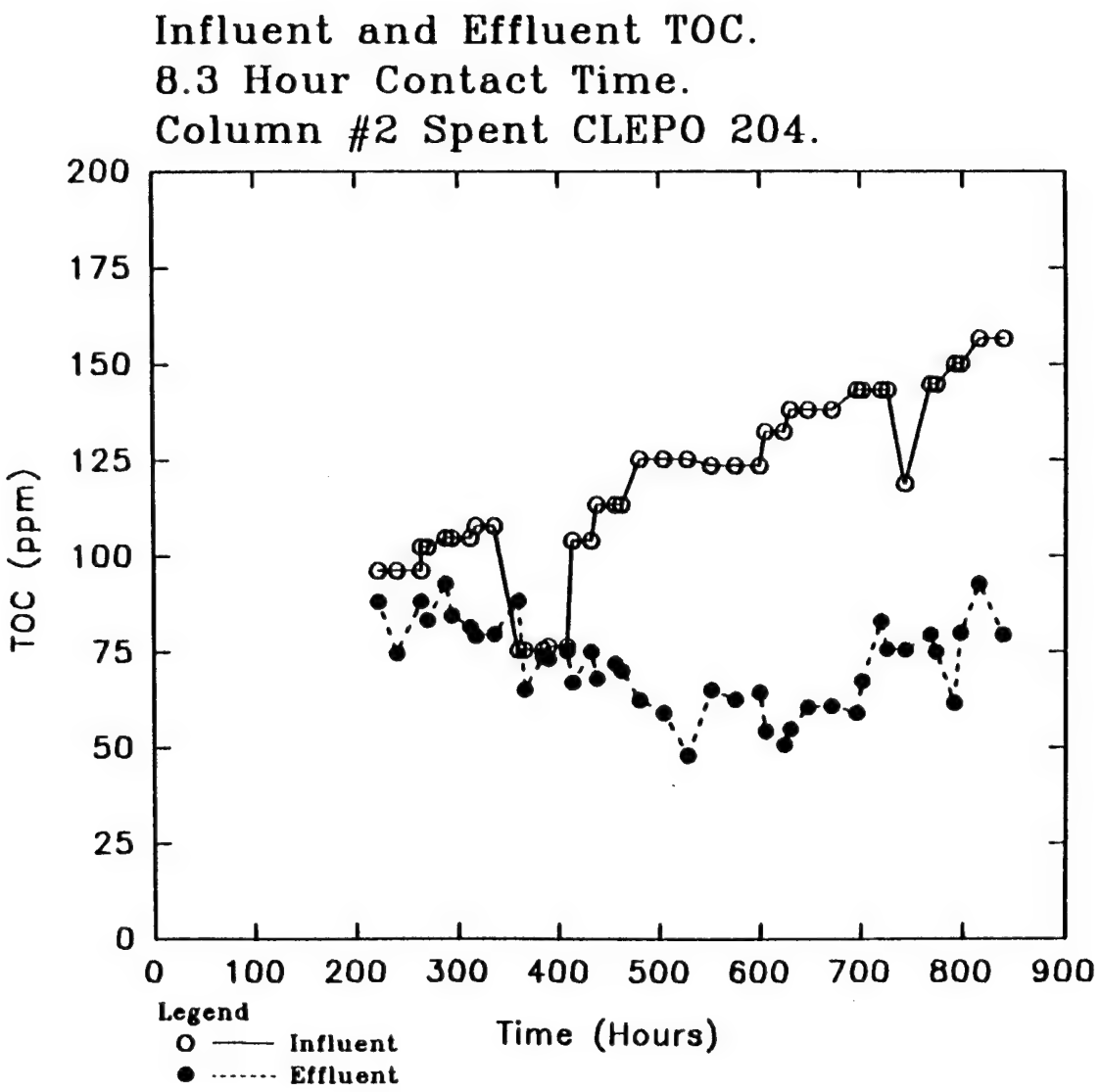



Effluent Ammonia.
5.3 v.s. 8.3 Hour Contact Time.
Column #2 Spent CLEPO 204.
5.3 Hour
Contact Time.
8.3 Hour
Contact Time.
Effluent Ammonia (ppm)
Time (Hours)
0
5
10
15
20
25
30
0
40
80
120
160
200
240
280
320

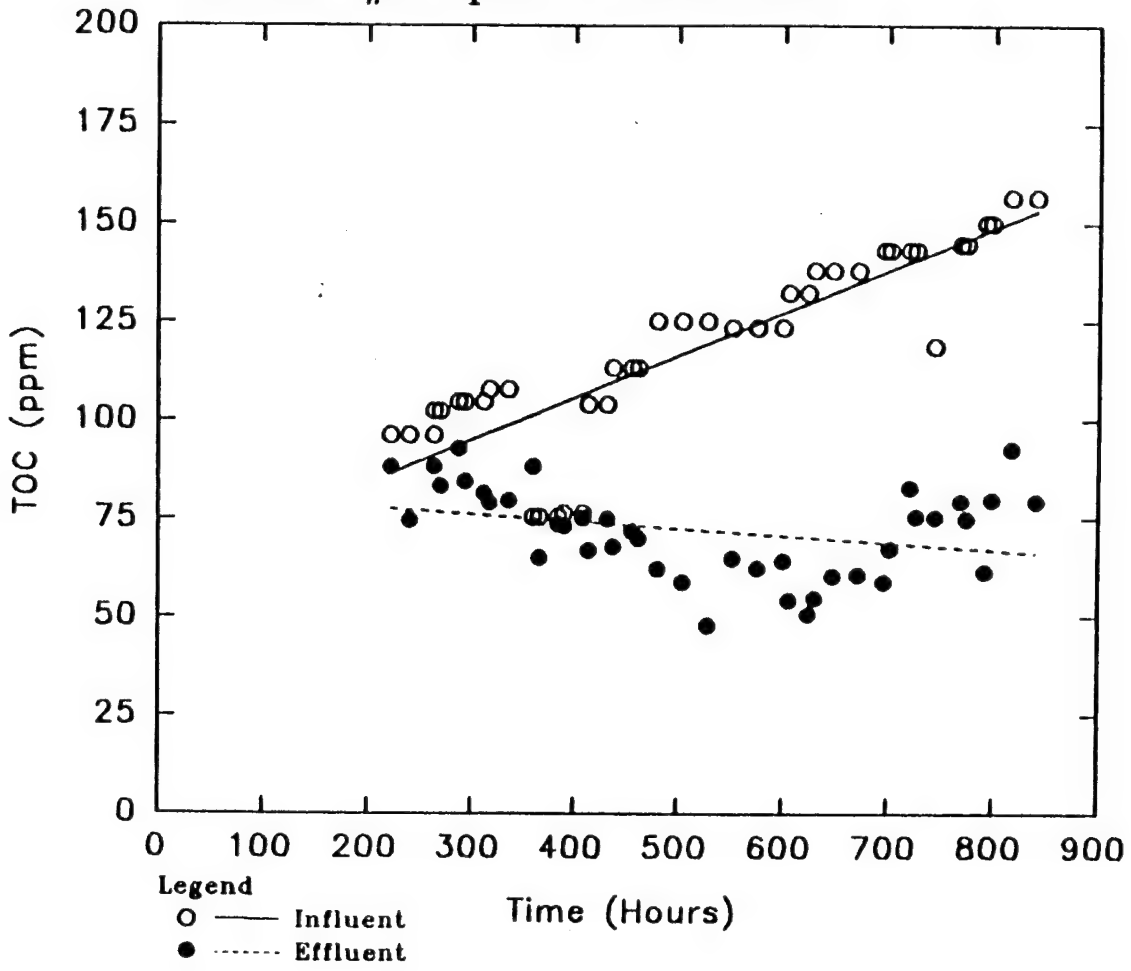

Effluent Ammonia.
Column #2 Spent CLEPO 204.
5.3 Hour
Contact
Time.
8.3 Hour
Contact Time.
Effluent Ammonia (ppm)
50
45
40
35
30
25
20
15
10
5
0
0
150
300
450
600
750
900
Time (Hours)

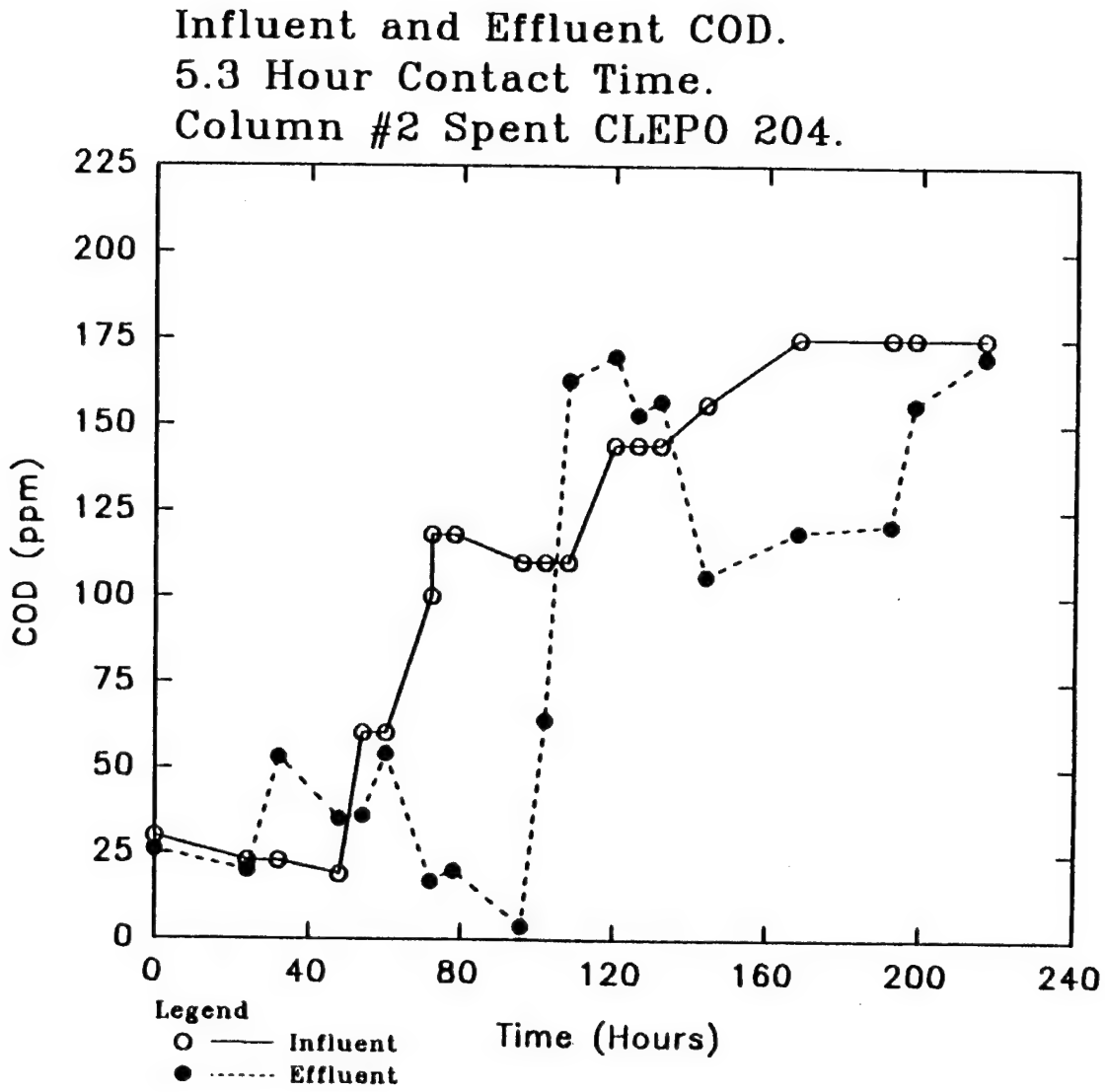

Influent and Effluent TOC.
5.3 Hour Contact Time.
Column #2 Spent CLEPO 204.
150
125
100
75
50
25
0
TOC (ppm)
0
40
80
120
160
200
240
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent TOC.
5.3 Hour Contact Time.
Column #2 Spent CLEPO 204.
150
125
100
75
50
25
0
TOC (ppm)
0
40
80
120
160
200
240
Time (Hours)
Legend
Influent
Effluent

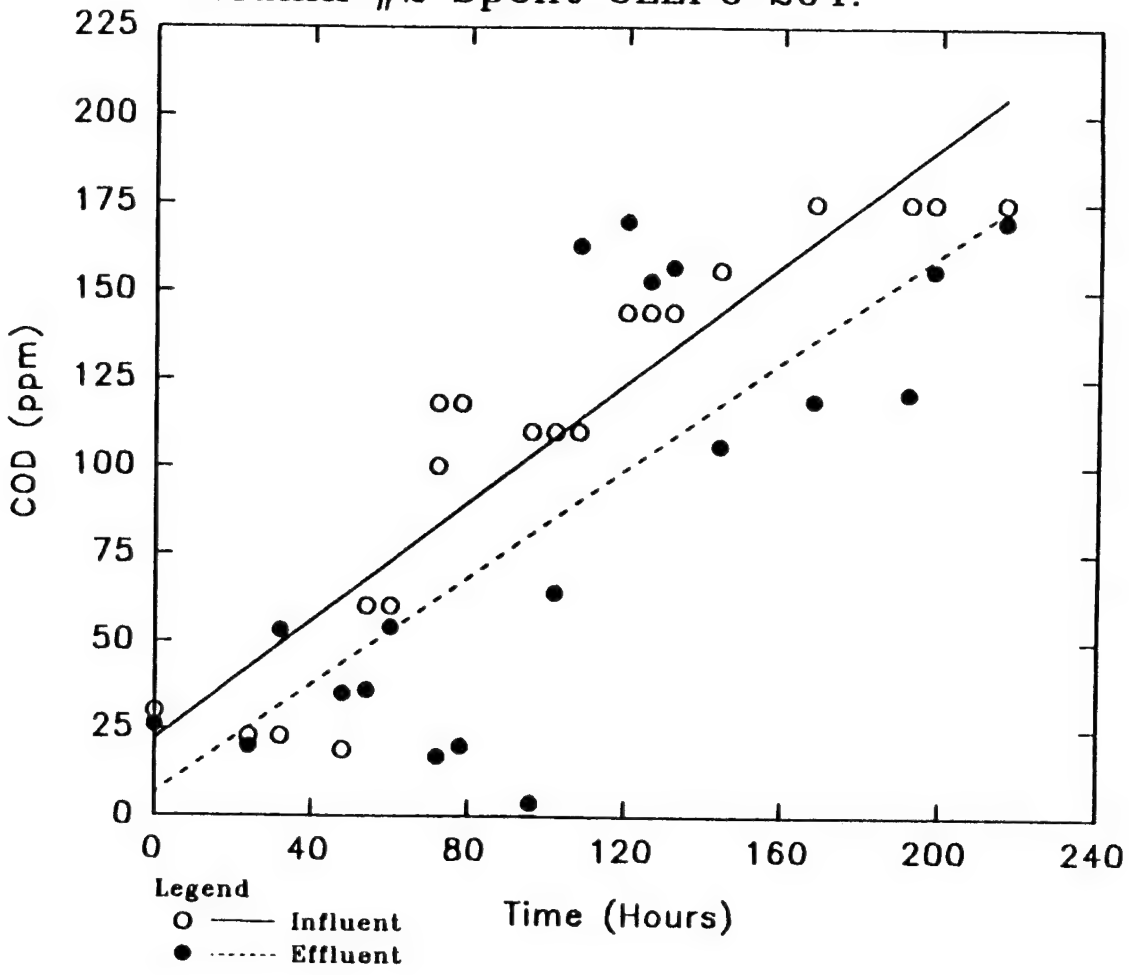

Influent and Effluent TOC.
8.3 Hour Contact Time.
Column #2 Spent CLEPO 204.
TOC (ppm)
200
175
150
125
100
75
50
25
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent

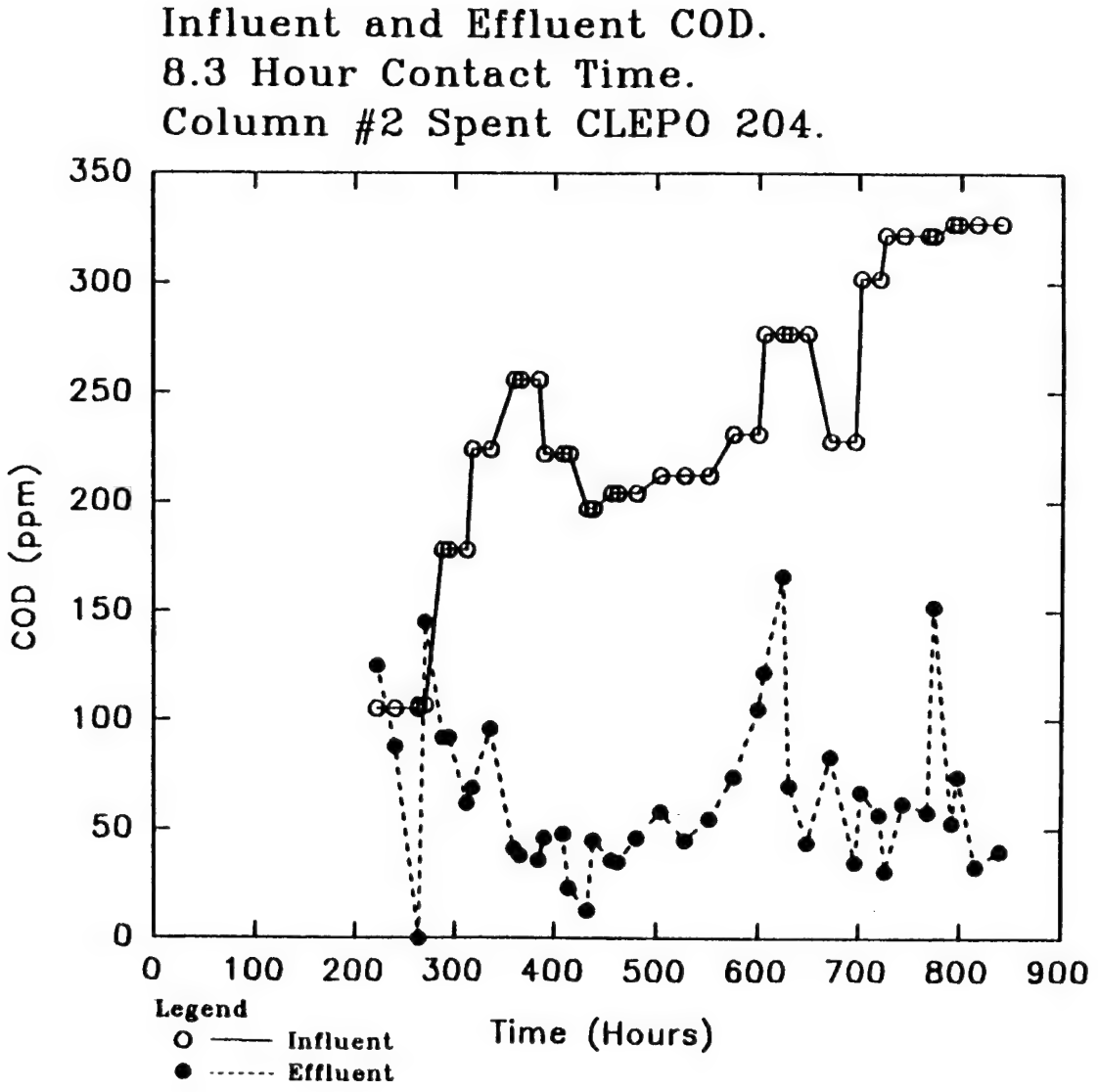
Influent and Effluent TOC.
8.3 Hour Contact Time.
Column #2 Spent CLEPO 204.

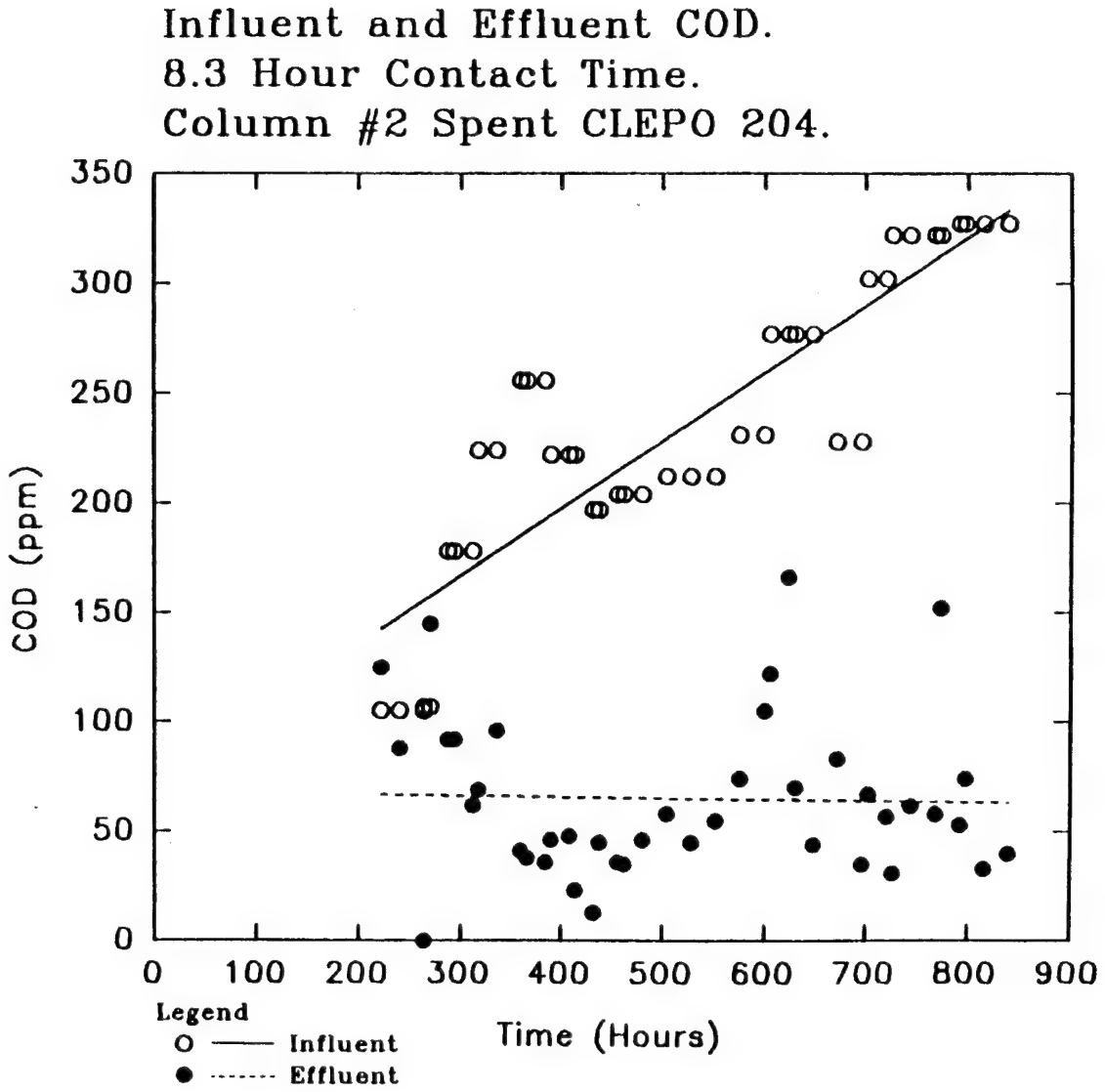


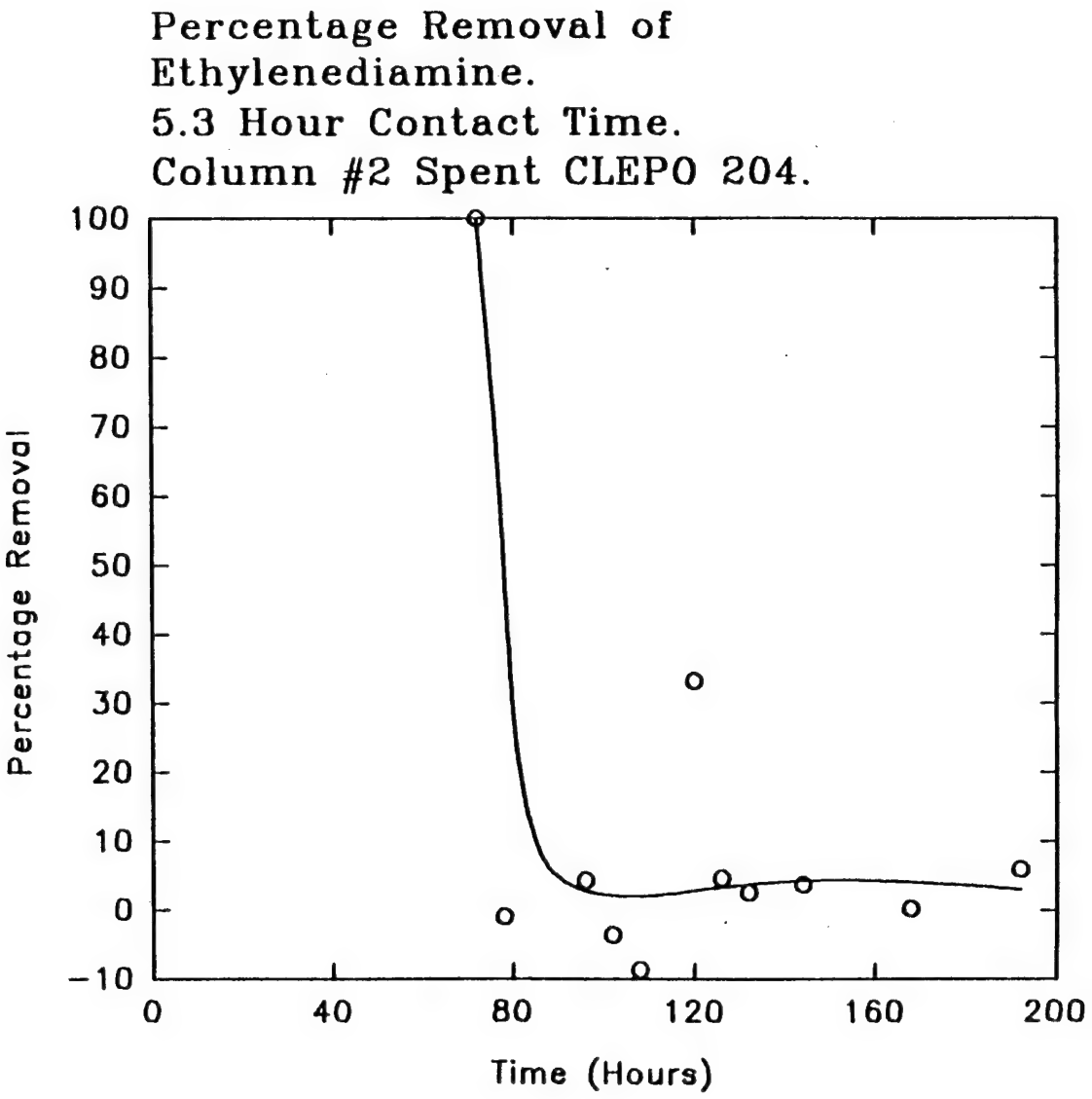

Influent and Effluent COD.
5.3 Hour Contact Time.
Column #2 Spent CLEPO 204.
COD (ppm)
225
200
175
150
125
100
75
50
25
0
0
40
80
120
160
200
240
Time (Hours)
Legend
Influent
Effluent

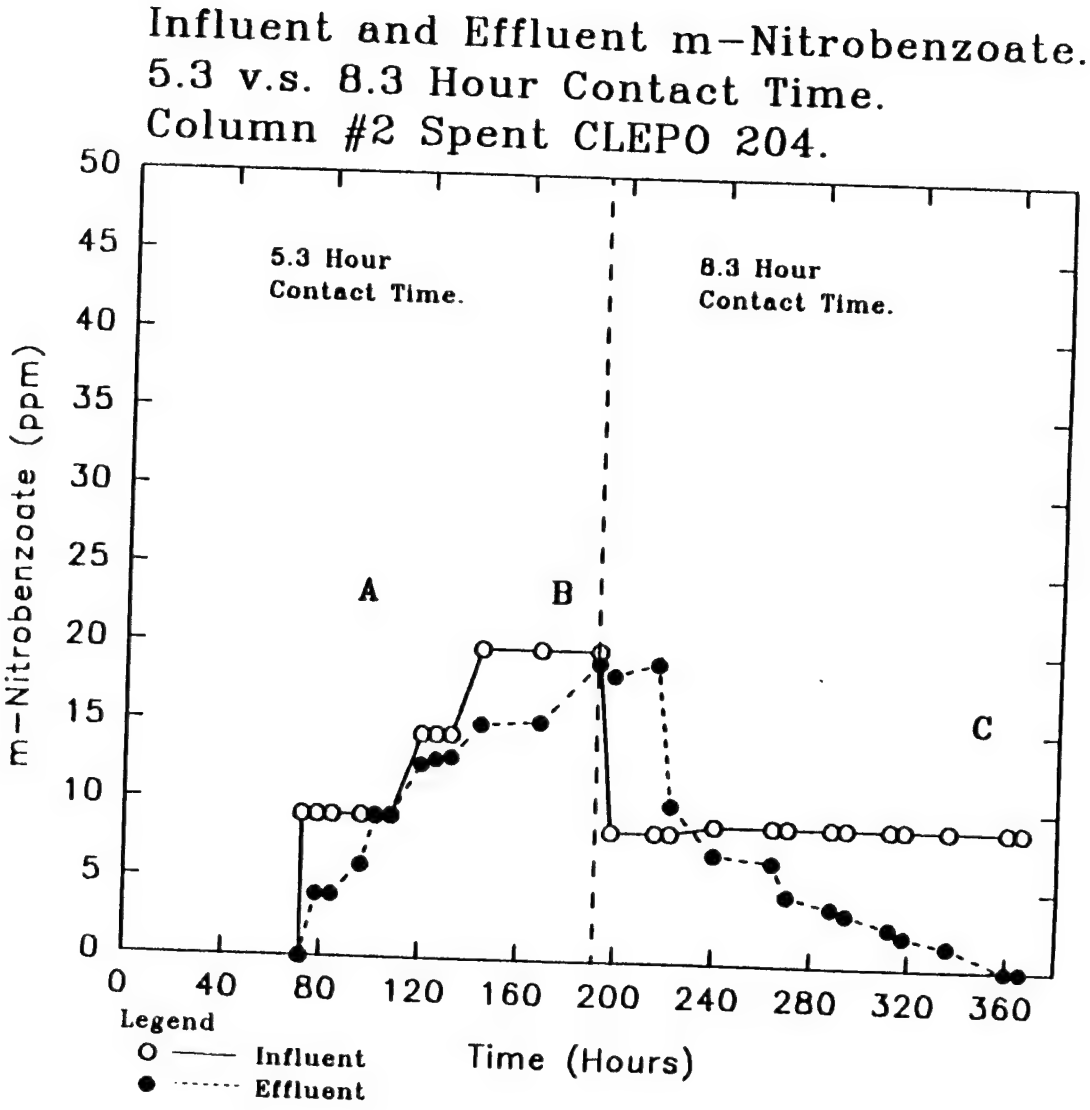
Influent and Effluent COD.
5.3 Hour Contact Time.
Column #2 Spent CLEPO 204.




Influent and Effluent COD.
8.3 Hour Contact Time.
Column #2 Spent CLEPO 204.
COD (ppm)
350
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent COD.
8.3 Hour Contact Time.
Column #2 Spent CLEPO 204.
COD (ppm)
350
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent


Percentage Removal of
Ethylenediamine.
5.3 Hour Contact Time.
Column #2 Spent CLEPO 204.
Percentage Removal
100
90
80
70
60
50
40
30
20
10
0
-10
0
40
80
120
160
200
Time (Hours)



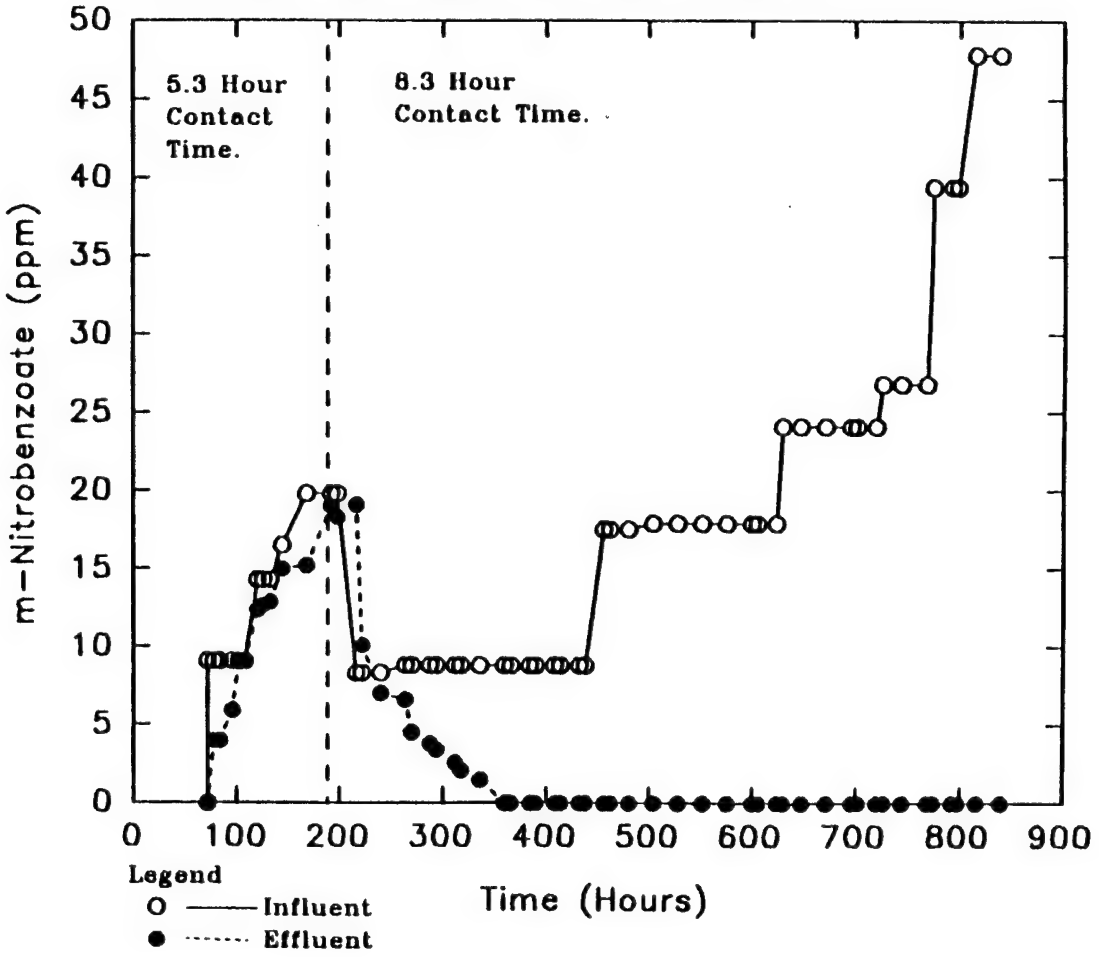
EVENTS:

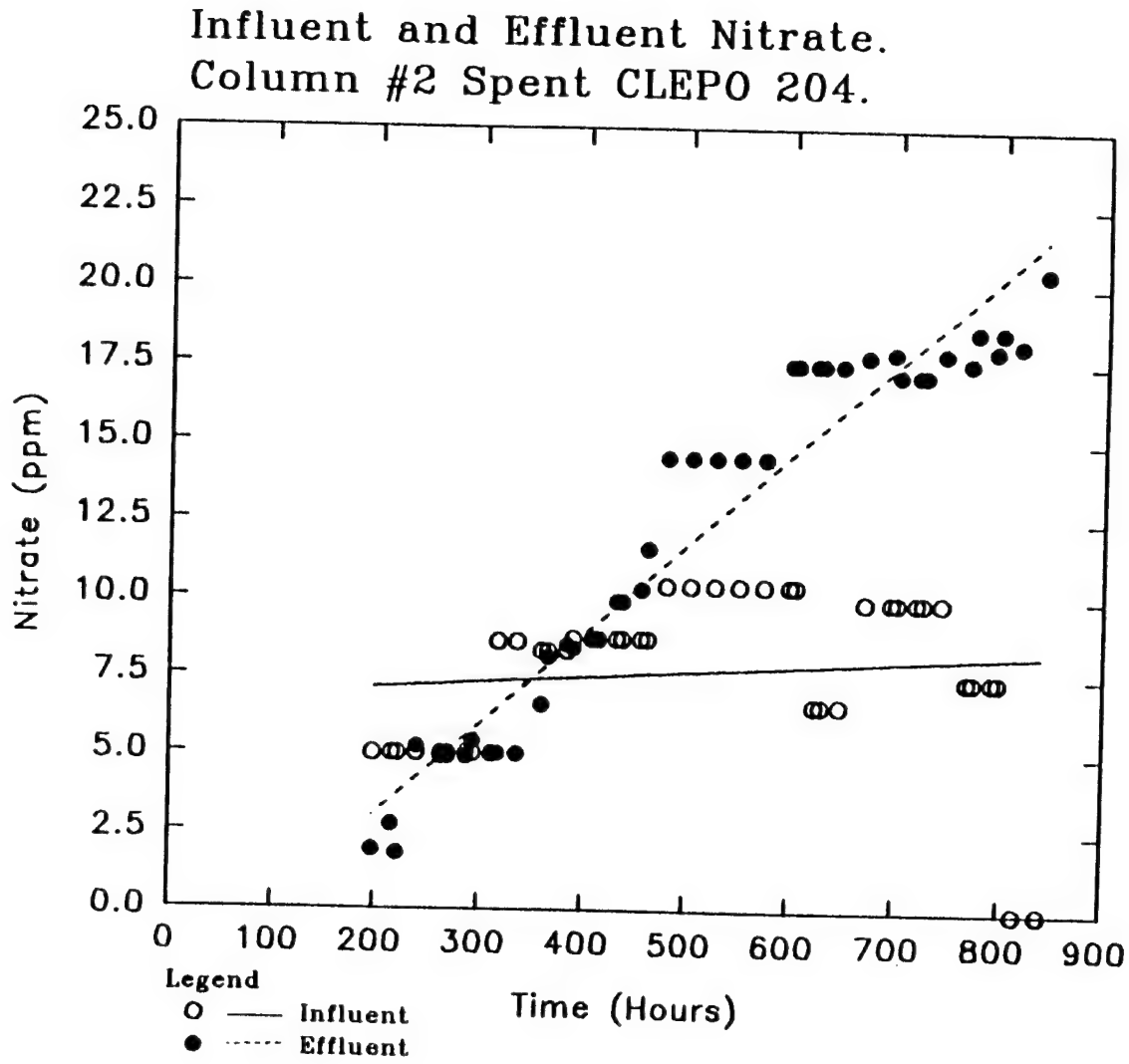
A. At an influent flow rate of 14 mL per minute (5.3 hour retention time), m-nitrobenzoate displayed poor removal from the effluent over a 120 hour exposure period.

B. At 192 hours the influent flow rate was decreased from 14 mL per minute to 9 mL per minute. m-Nitrobenzoate is slowly removed from the effluent starting at 240 hours.

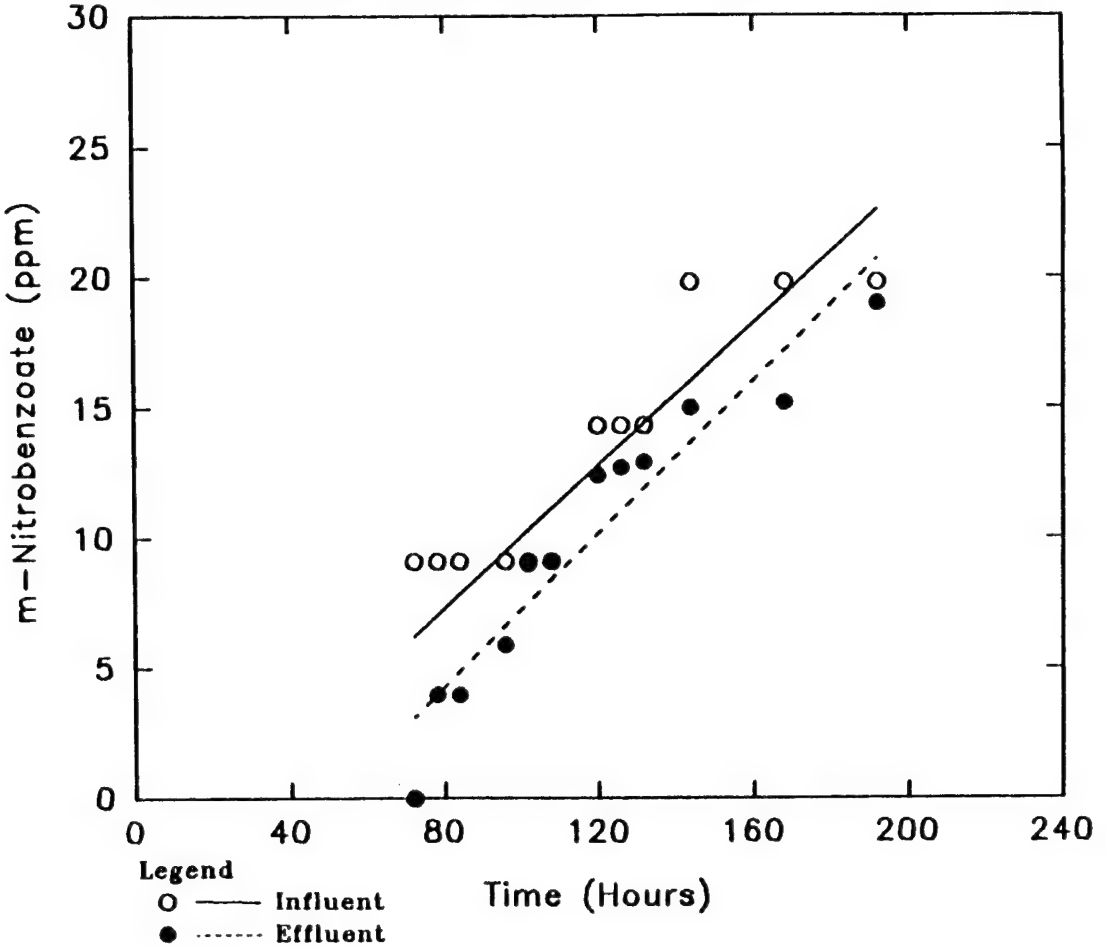
C. At 360 hours, effluent m-nitrobenzoate could not be detected.

Influent and Effluent m-Nitrobenzoate.
Column #2 Spent CLEPO 204.

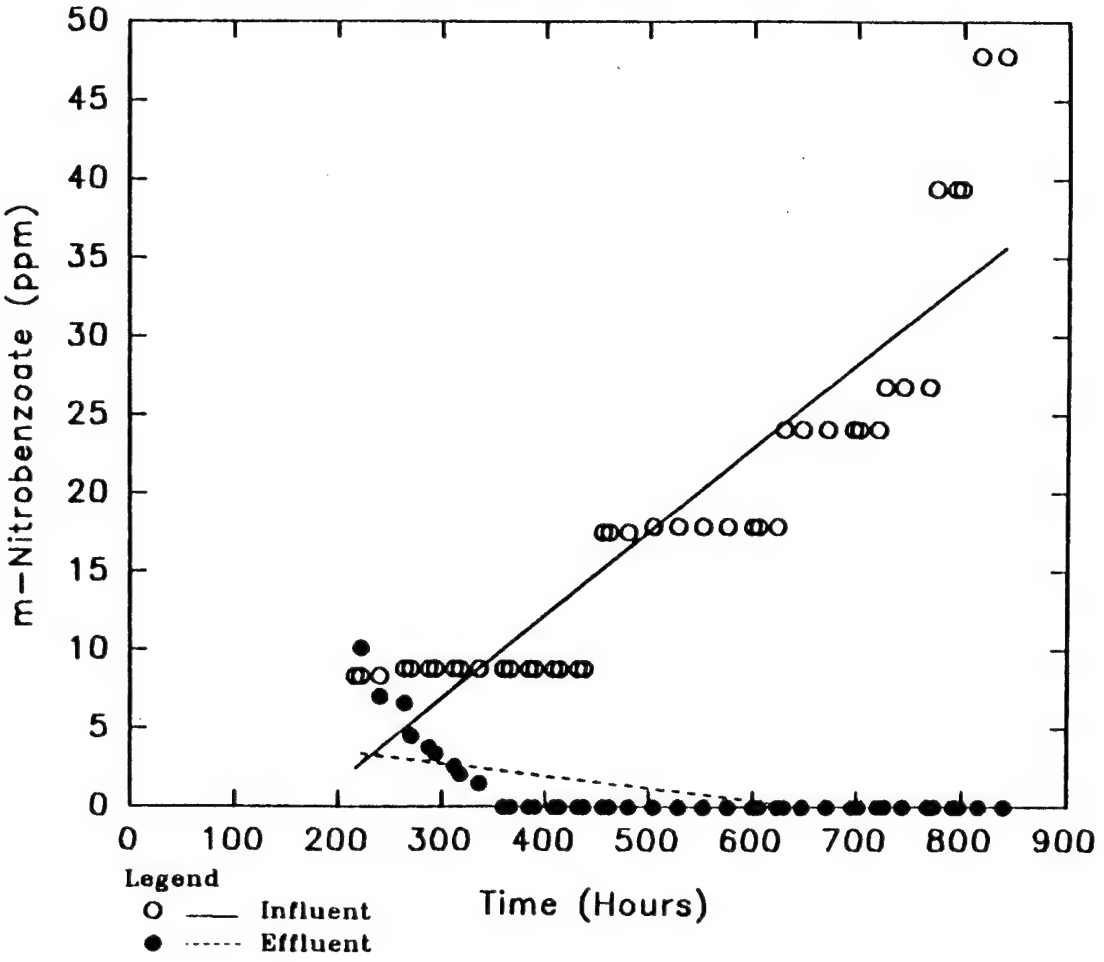


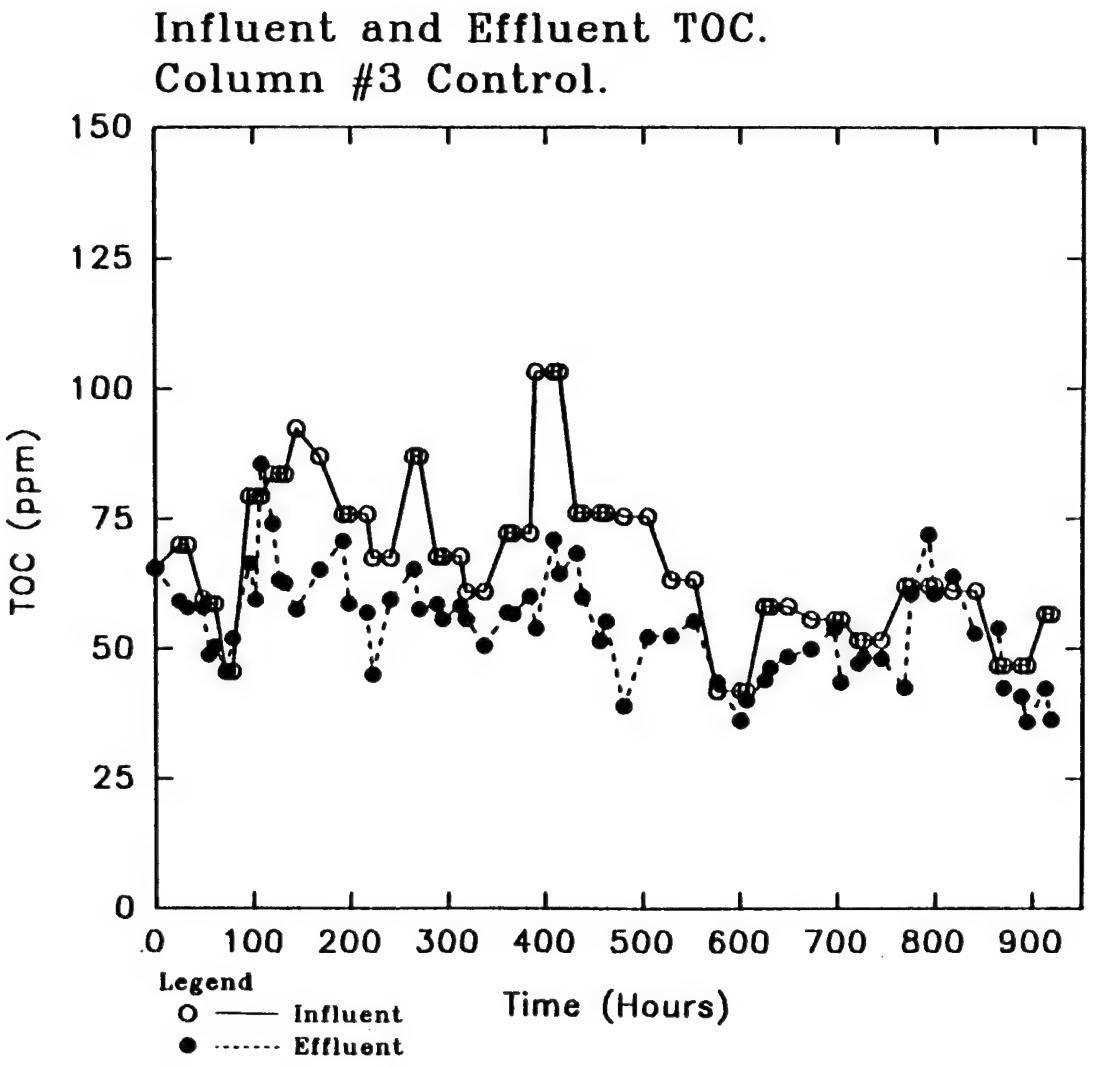

Influent and Effluent Nitrate.
Column #2 Spent CLEPO 204.
Nitrate (ppm)
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent

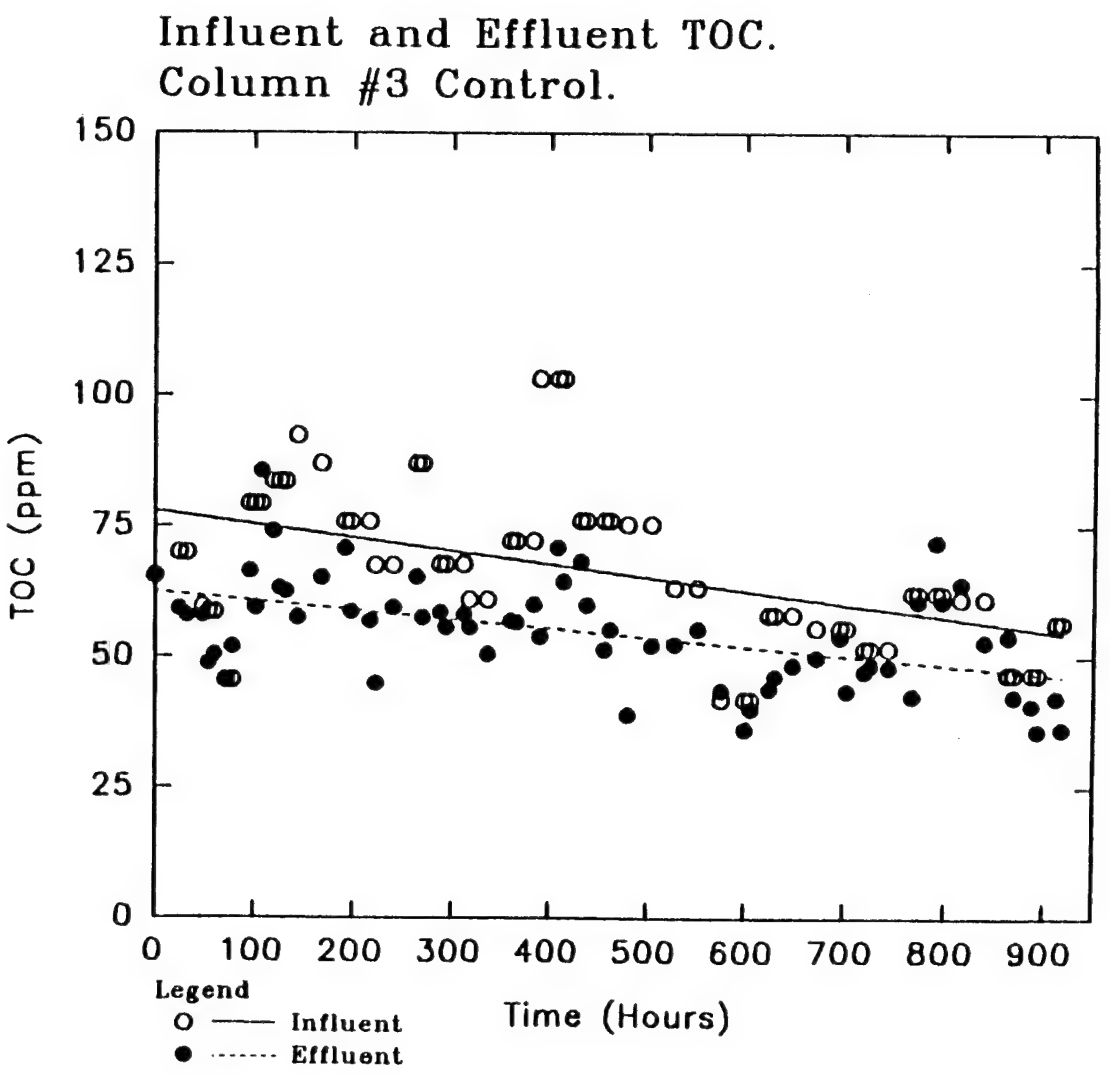
Influent and Effluent m-Nitrobenzoate.
5.3 Hour Contact Time.
Column #2 Spent CLEPO 204.

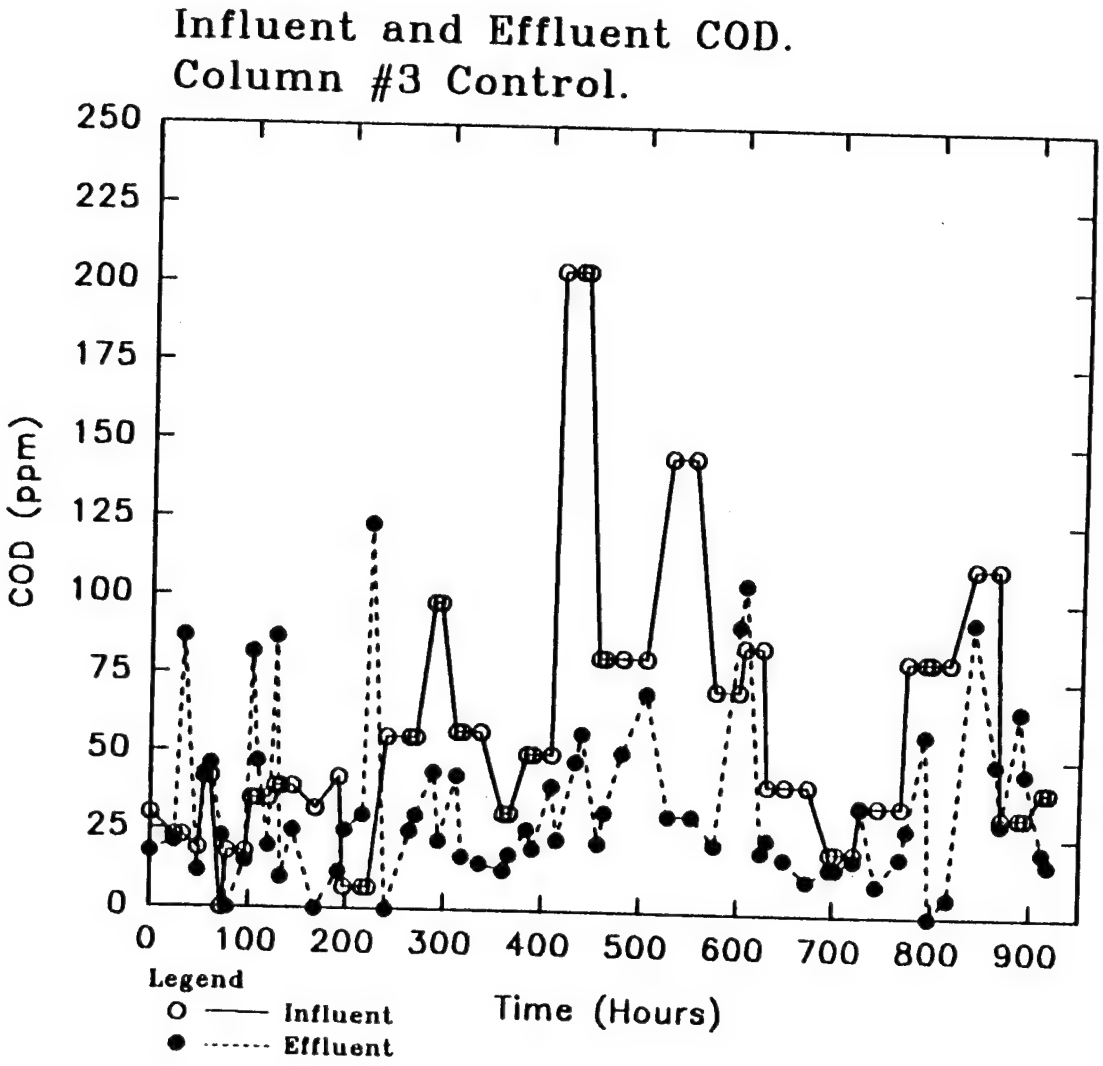


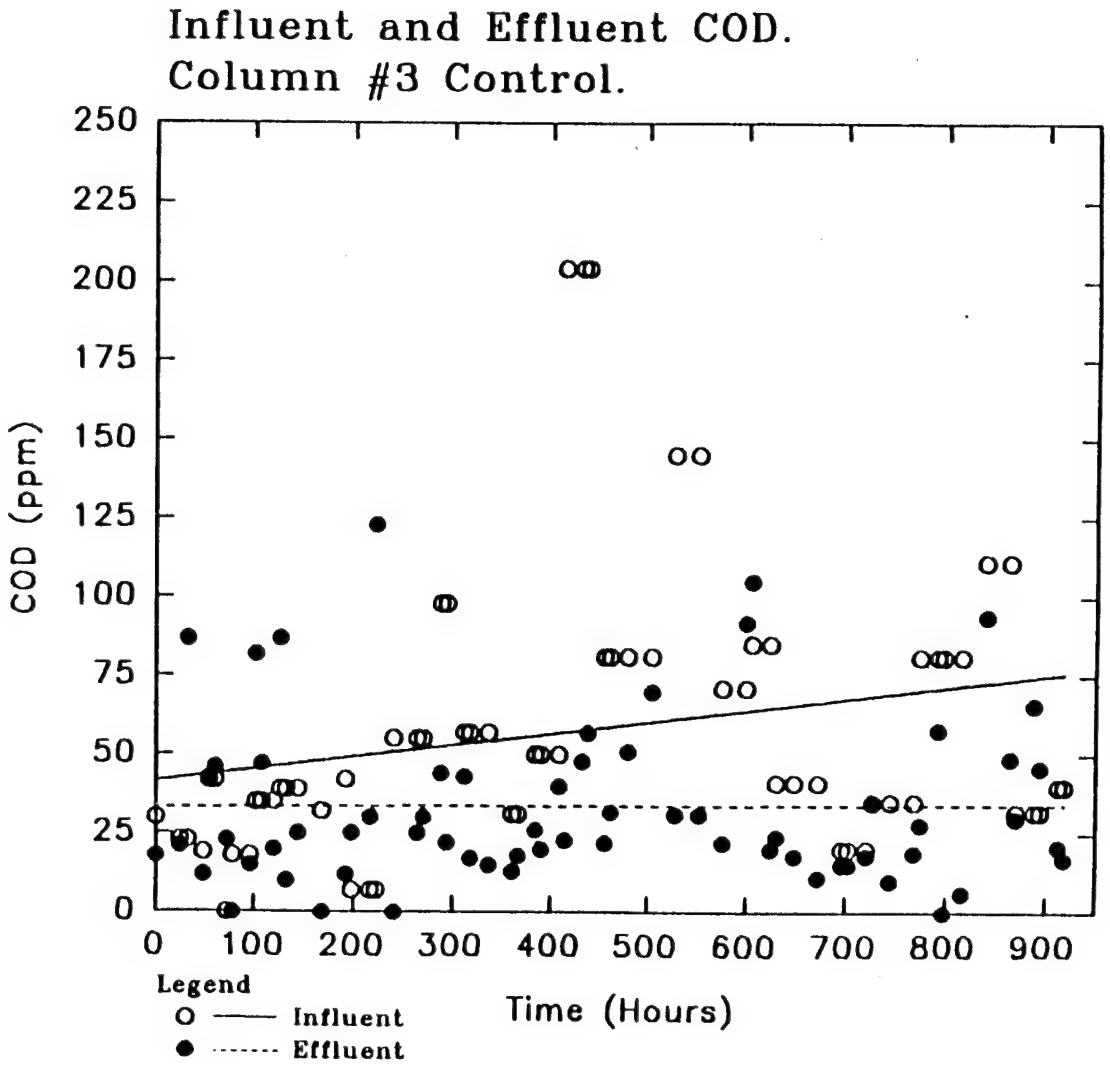
Influent and Effluent m-Nitrobenzoate.
8.3 Hour Contact Time.
Column #2 Spent CLEPO 204.

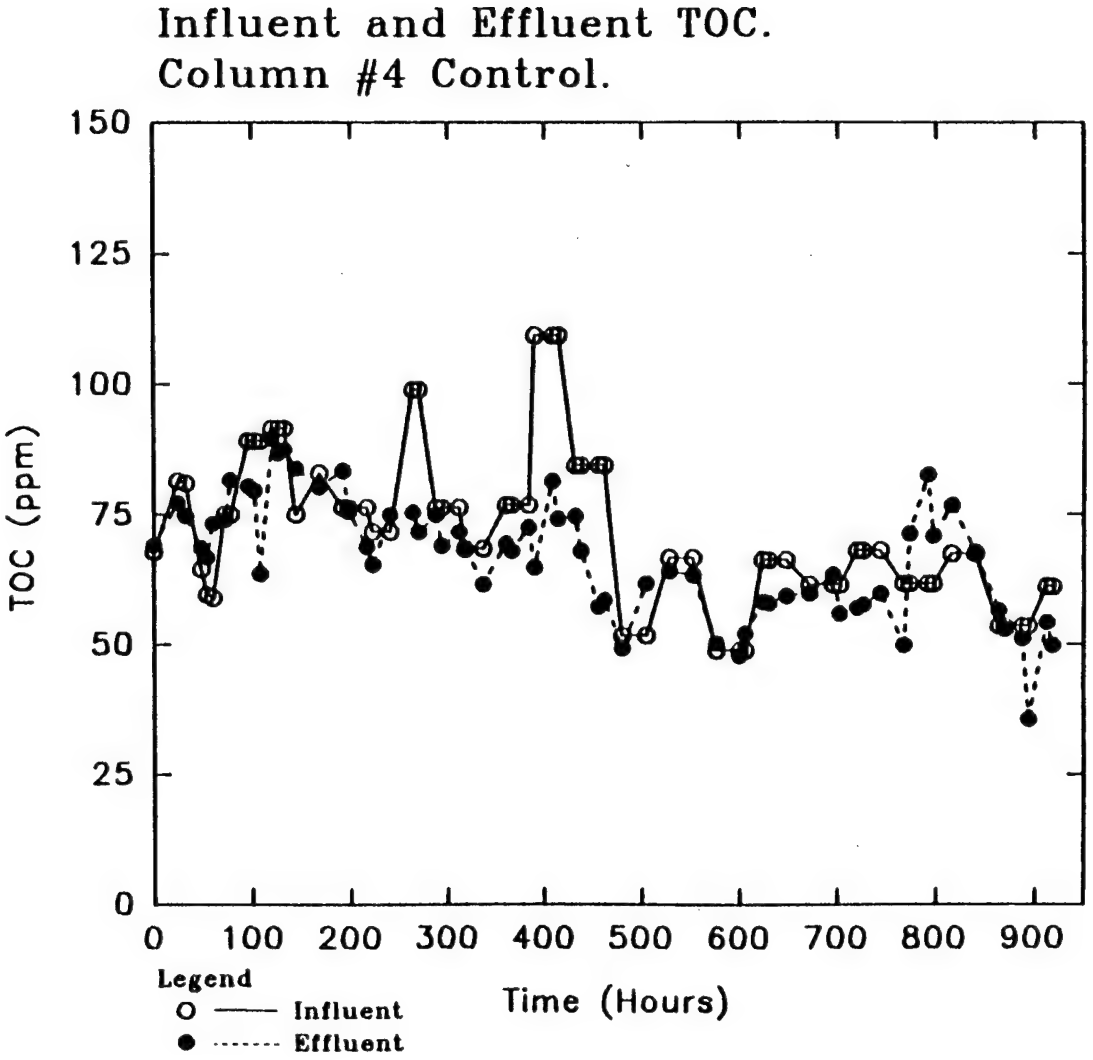


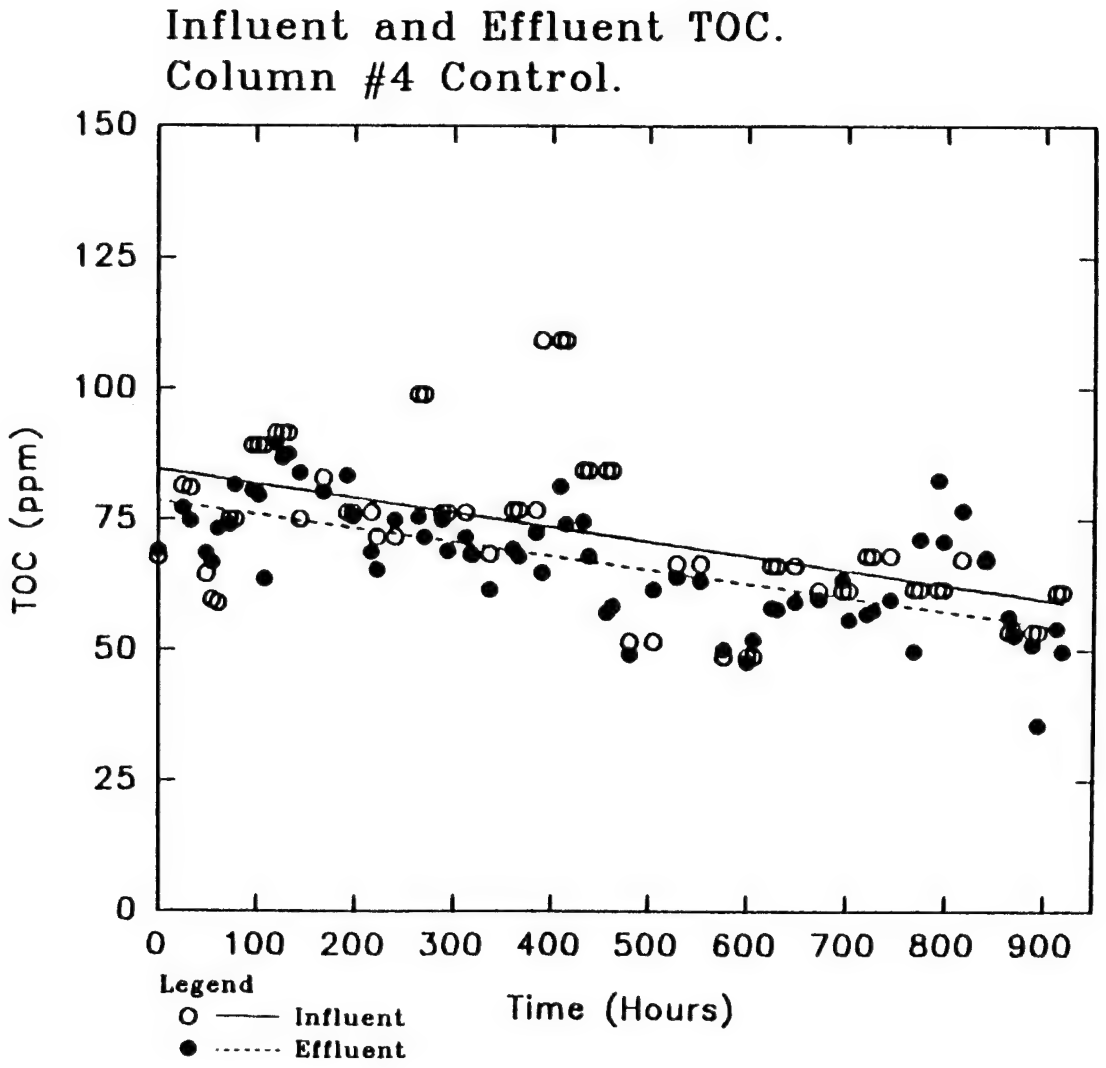

Influent and Effluent TOC.
Column #3 Control.
150
125
100
75
50
25
0
TOC (ppm)
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent TOC.
Column #3 Control.
150
125
100
75
50
25
0
TOC (ppm)
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent

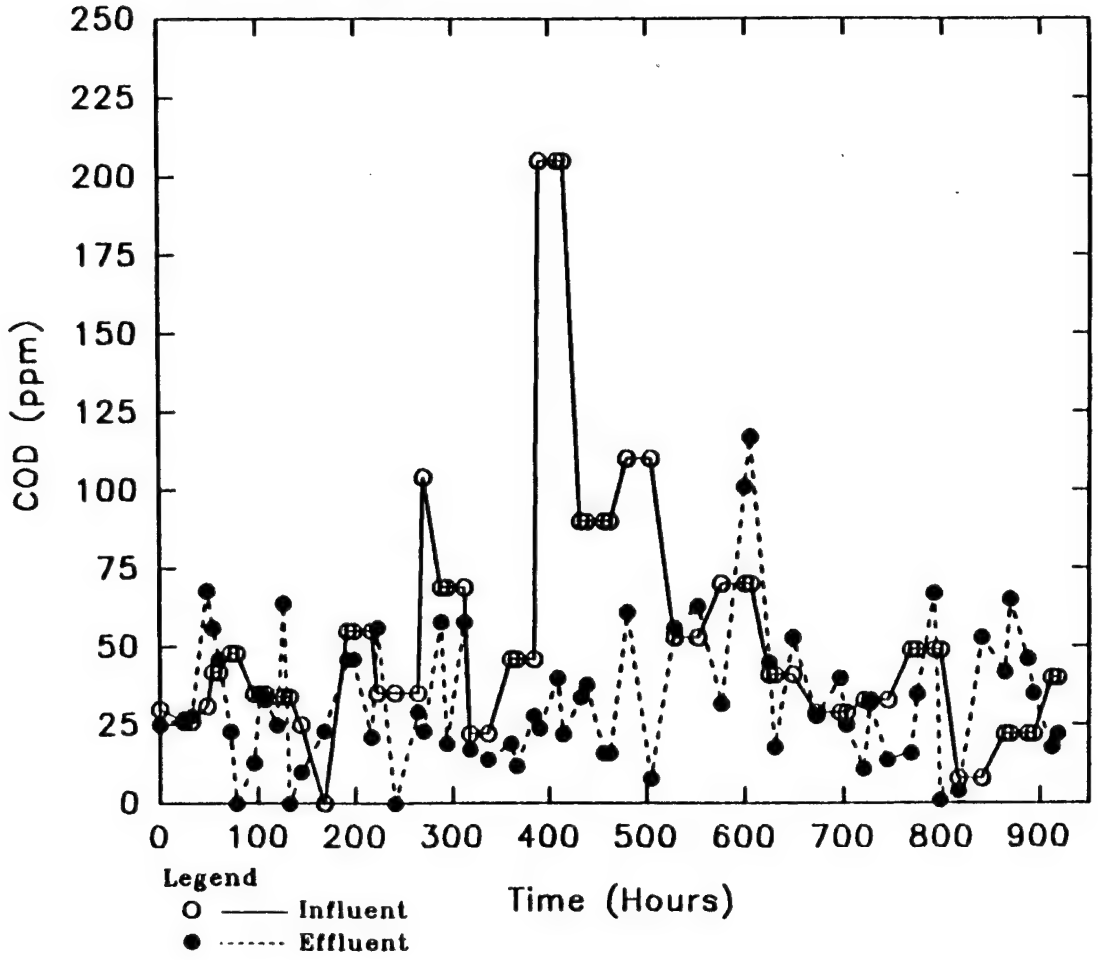

Influent and Effluent COD.
Column #3 Control.
COD (ppm)
250
225
200
175
150
125
100
75
50
25
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent

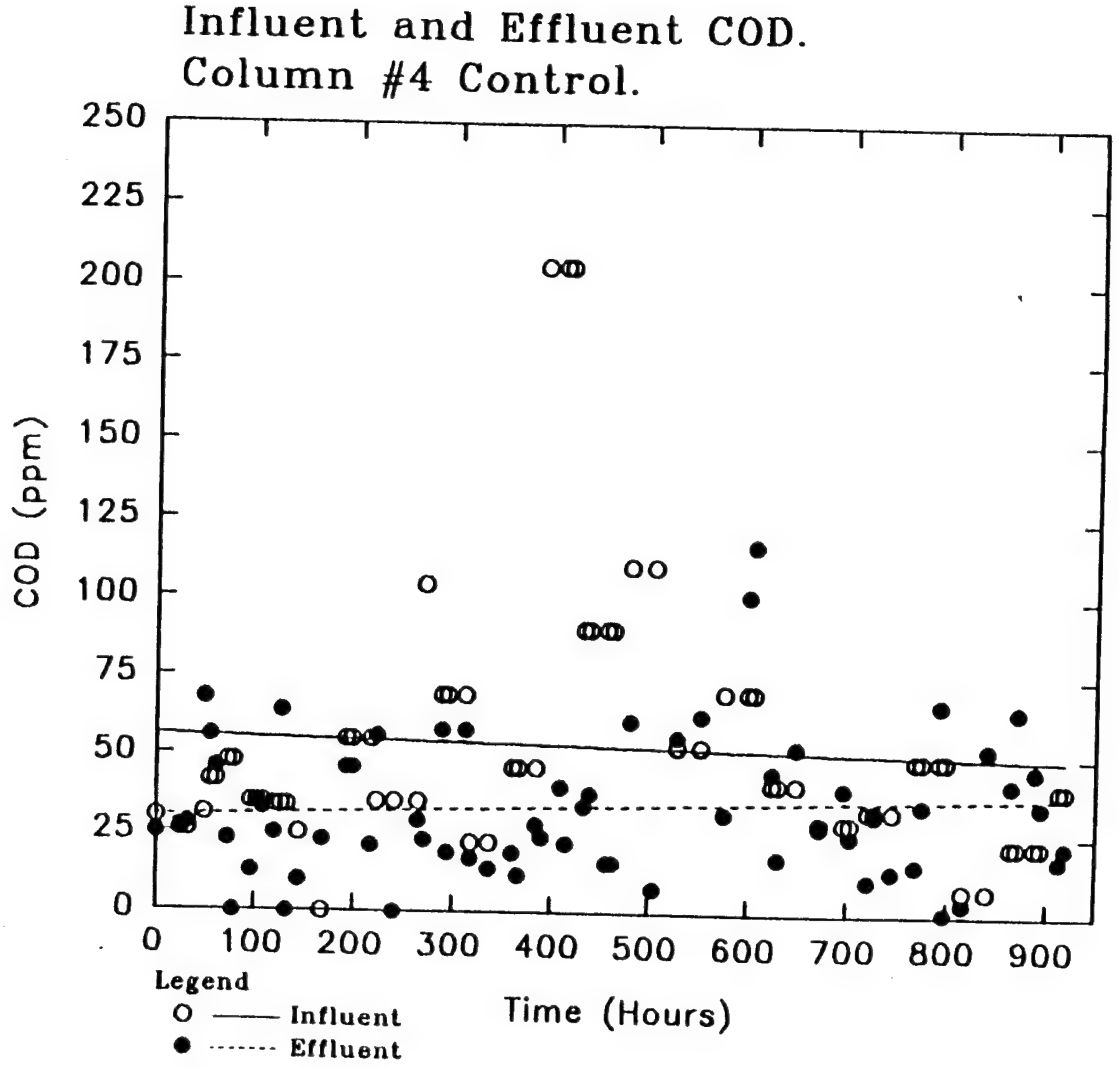

Influent and Effluent COD.
Column #3 Control.
COD (ppm)
250
225
200
175
150
125
100
75
50
25
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent TOC.
Column #4 Control.
150
125
100
75
50
25
0
TOC (ppm)
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent

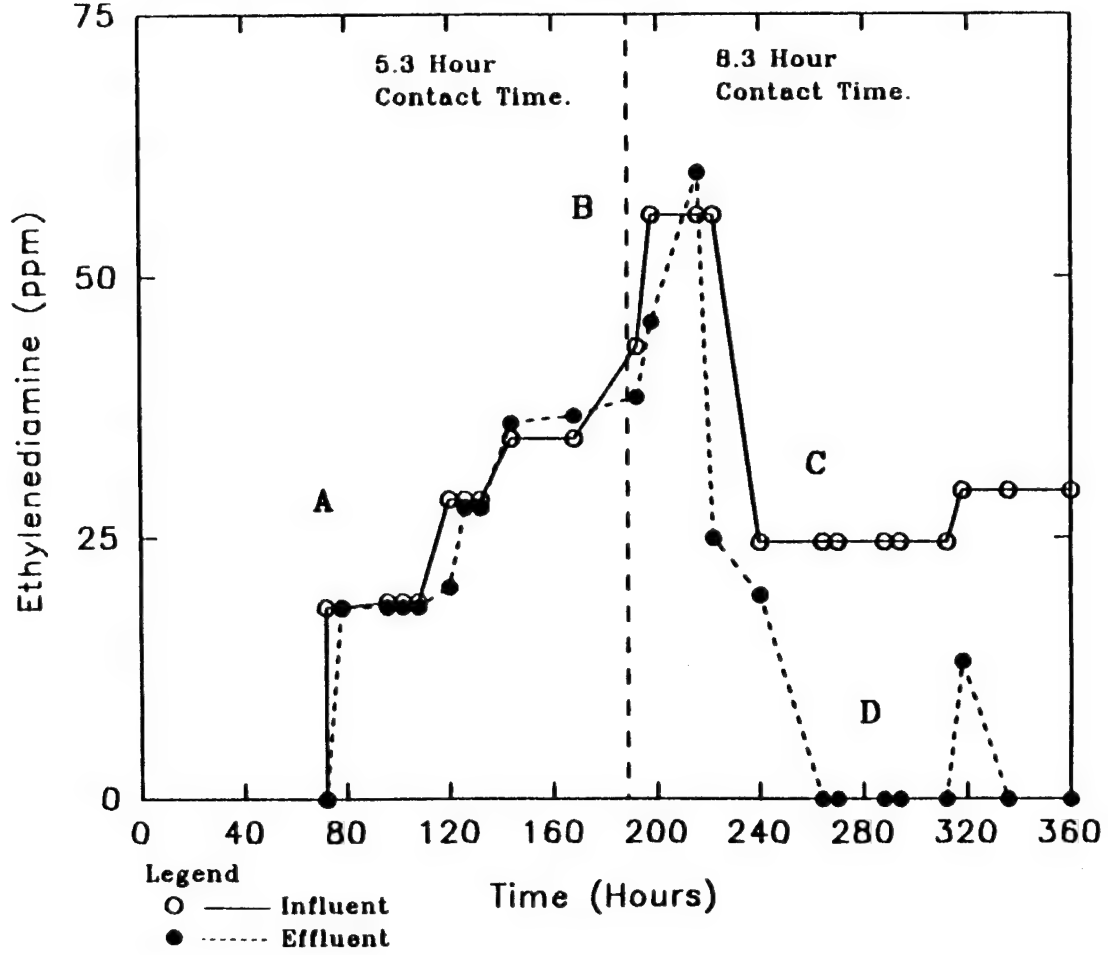

Influent and Effluent TOC.
Column #4 Control.
150
125
100
75
50
25
0
TOC (ppm)
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent

Influent and Effluent COD.
Column #4 Control.




Influent and Effluent COD.
Column #4 Control.
COD (ppm)
250
225
200
175
150
125
100
75
50
25
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent

Influent and Effluent Ethylenediamine. 5.3 v.s. 8.3 Hour Contact Time. Column #5 Spent CLEPO 204.



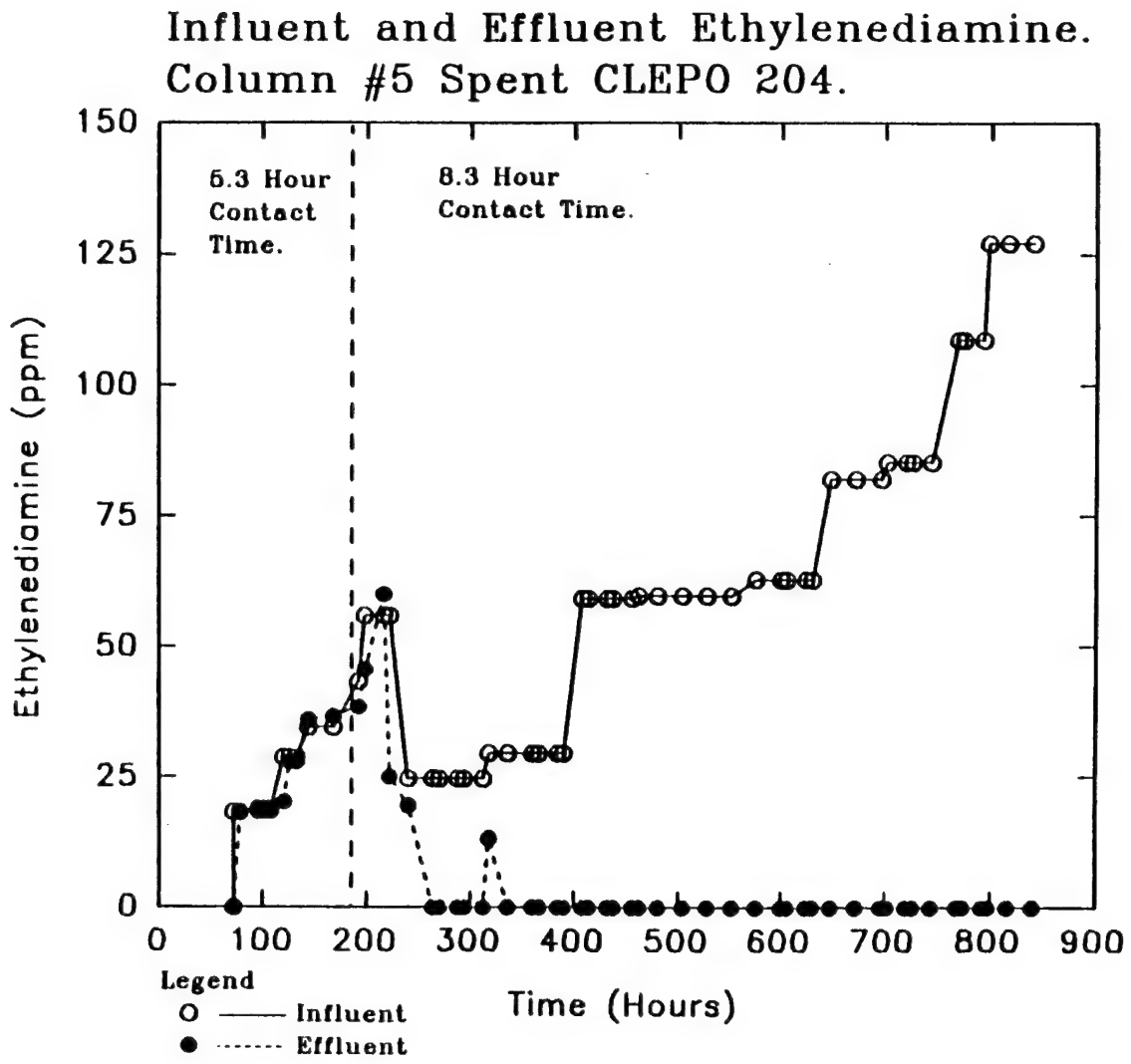
EVENTS:

A. At 72 hours the influent was spiked with spent CLEPO 204 which had 18.3 ppm ethylendiamine.

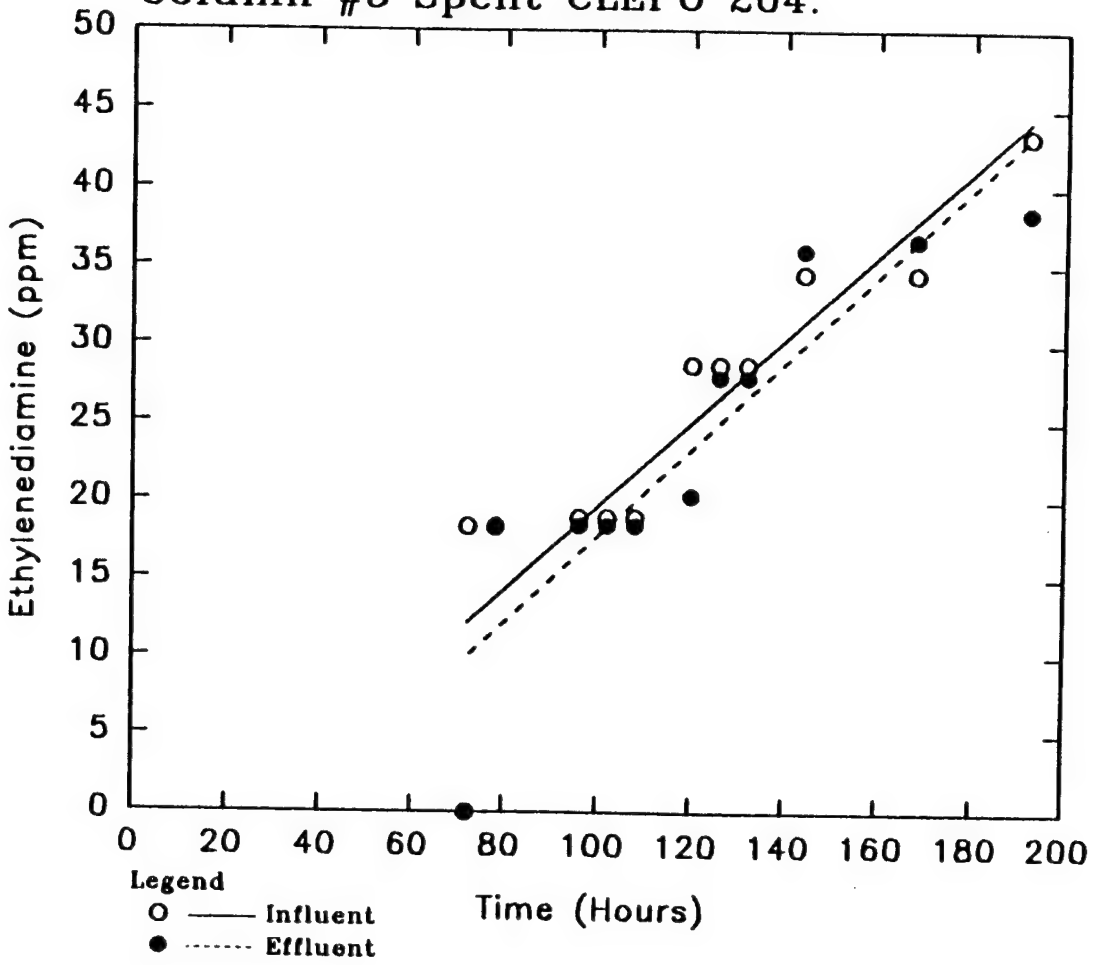
B. At 192 hours the influent flow rate was decreased to 9 mL per minute from 14 mL per minute. This increased the retention time from 5.3 hours to 8.3 hours.

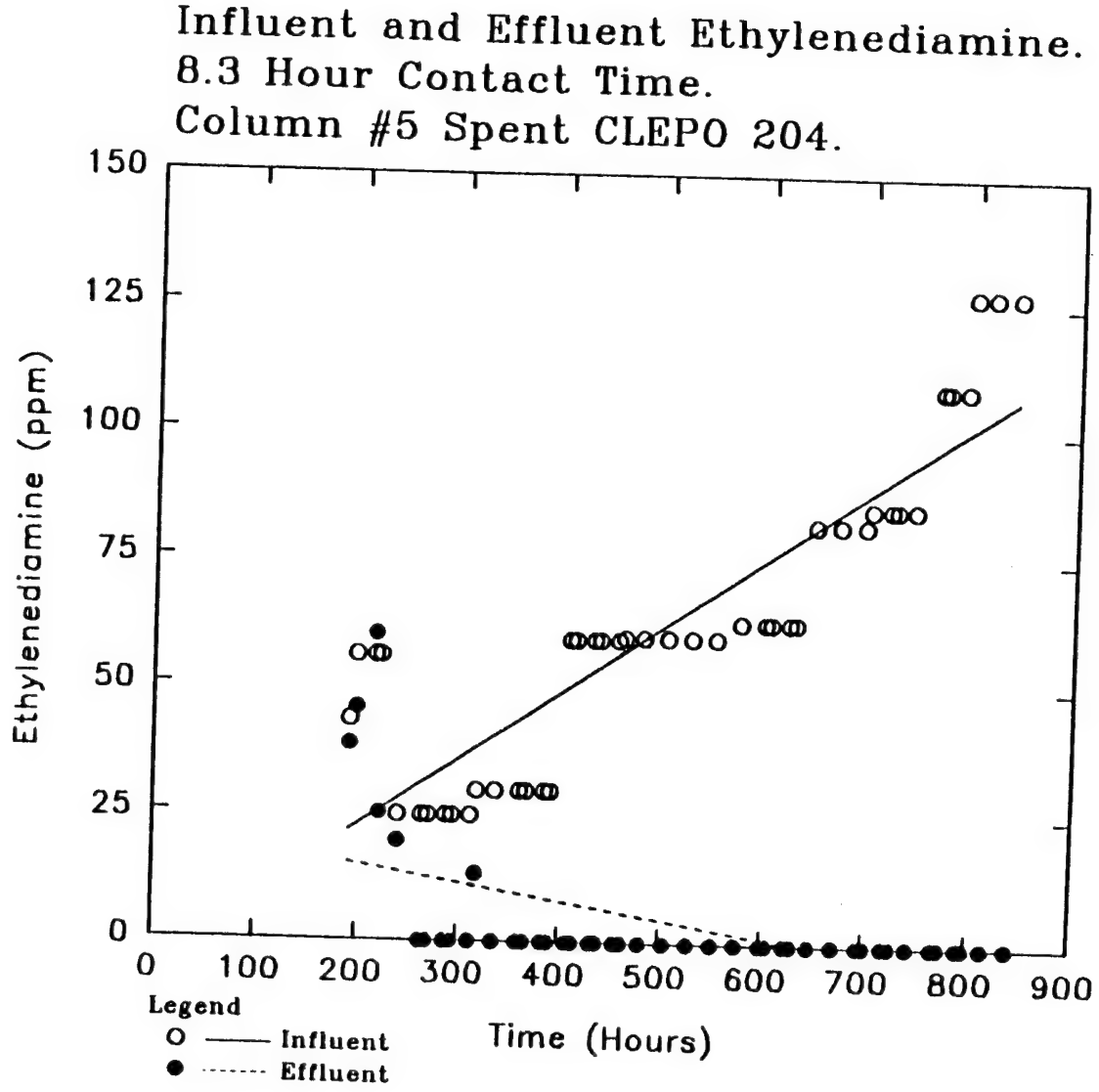
C. Observed ethylenediamine removal began at 222 hours.

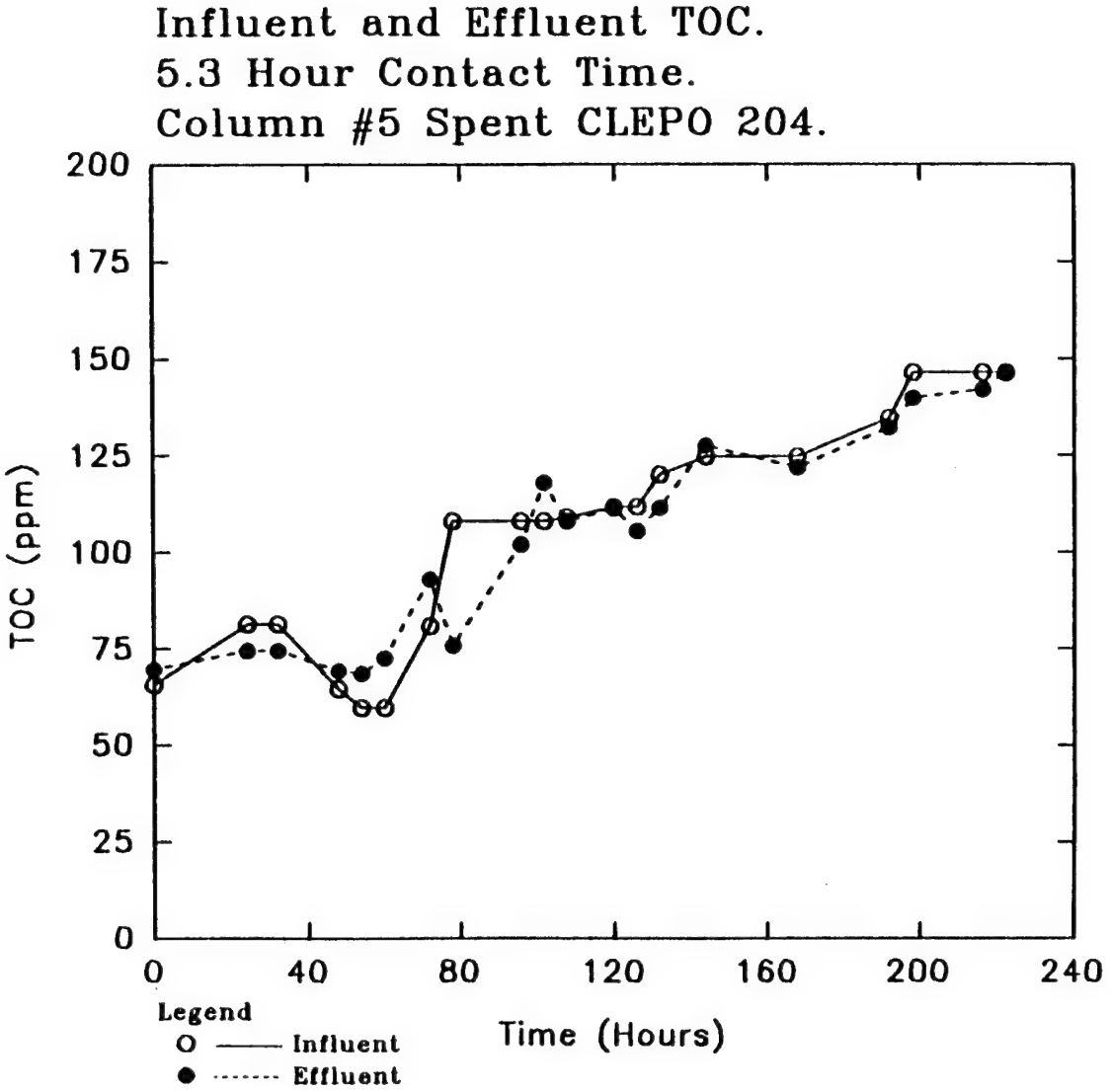
D. Ethylenediamine was not detected in the effluent at 264 hours.

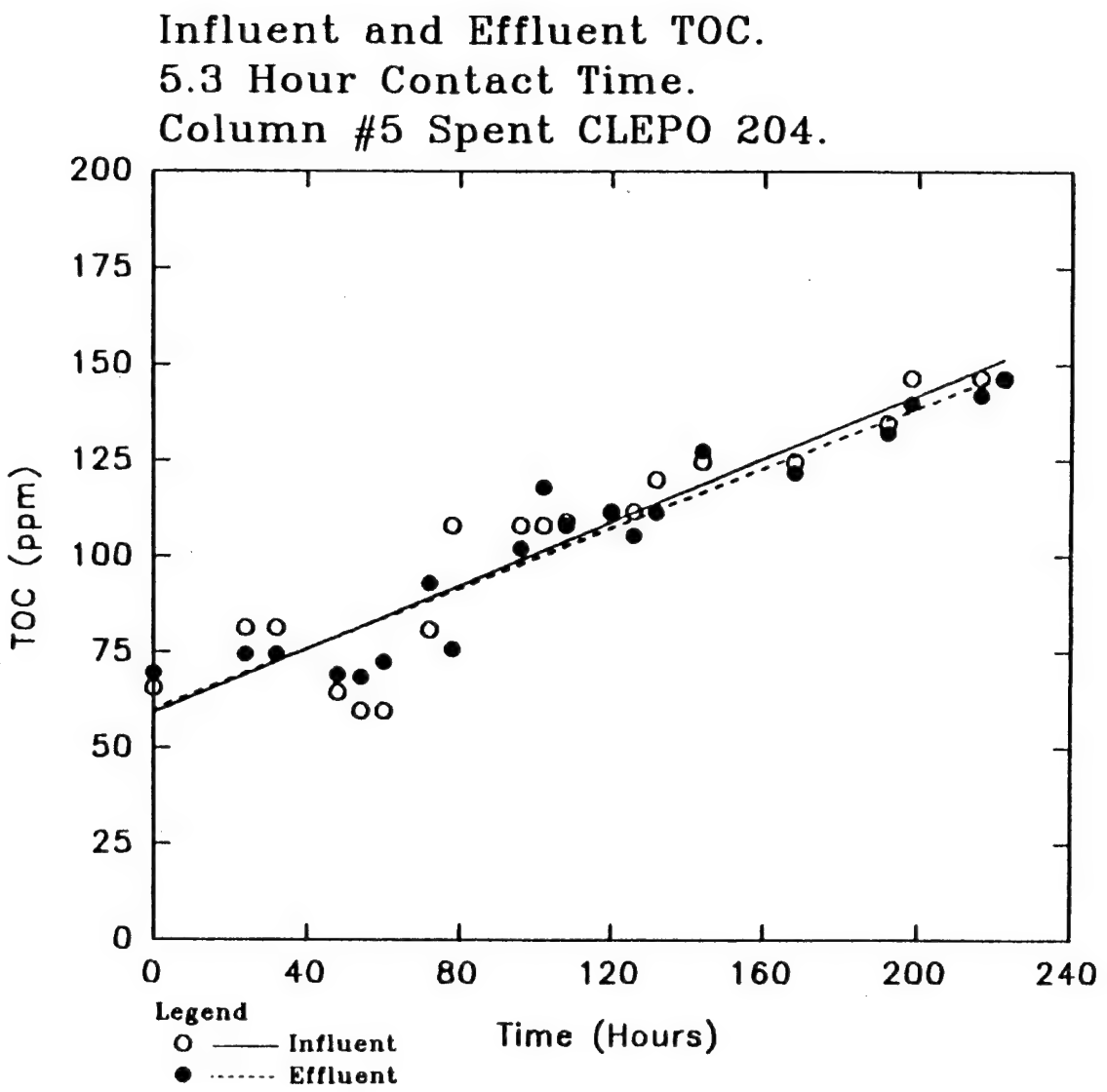

Influent and Effluent Ethylenediamine.
Column #5 Spent CLEPO 204.
5.3 Hour
Contact
Time.
8.3 Hour
Contact Time.
Ethylenediamine (ppm)
150
125
100
75
50
25
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent

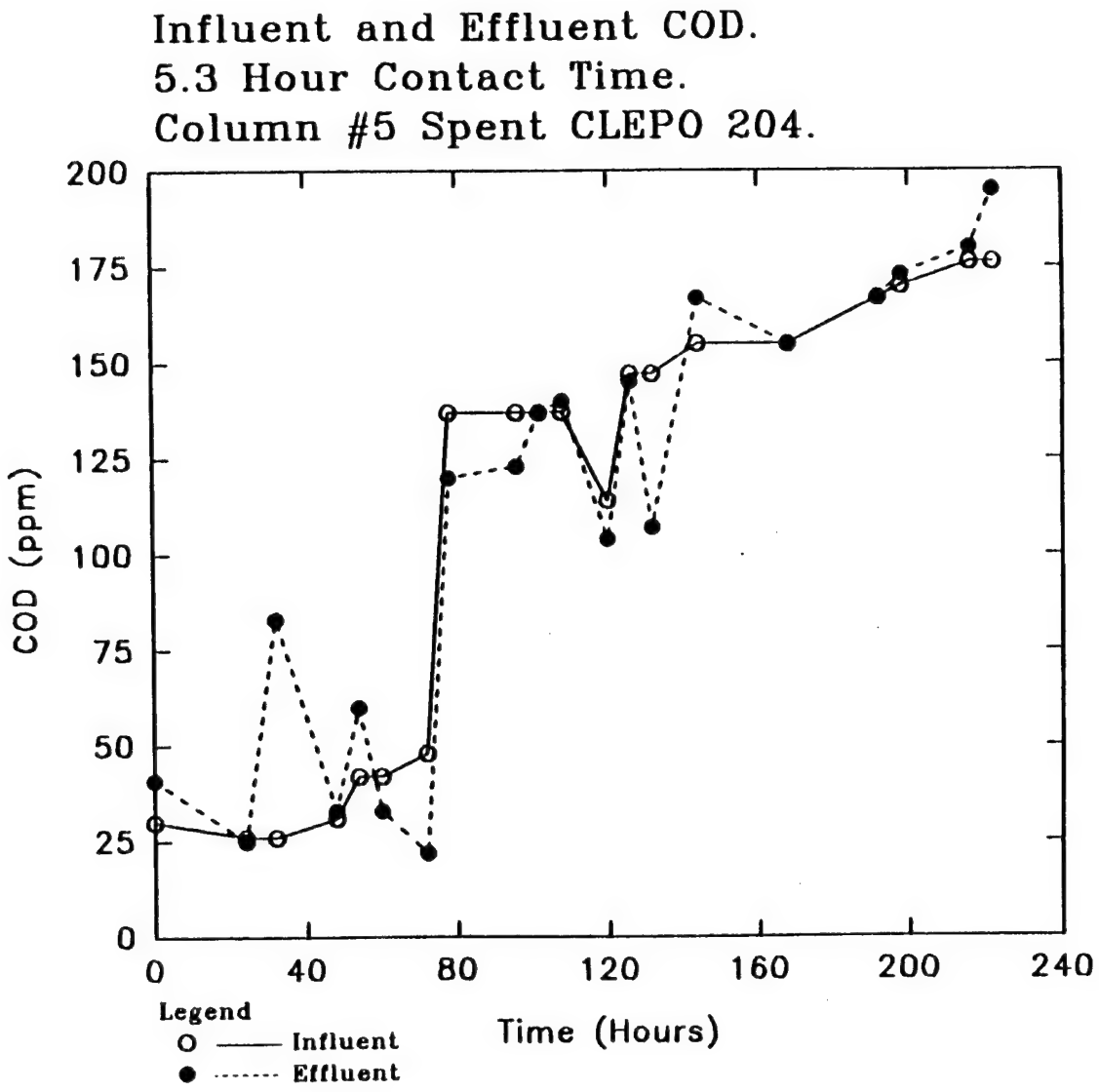
Influent and Effluent Ethylenediamine.
5.3 Hour Contact Time.
Column #5 Spent CLEPO 204.

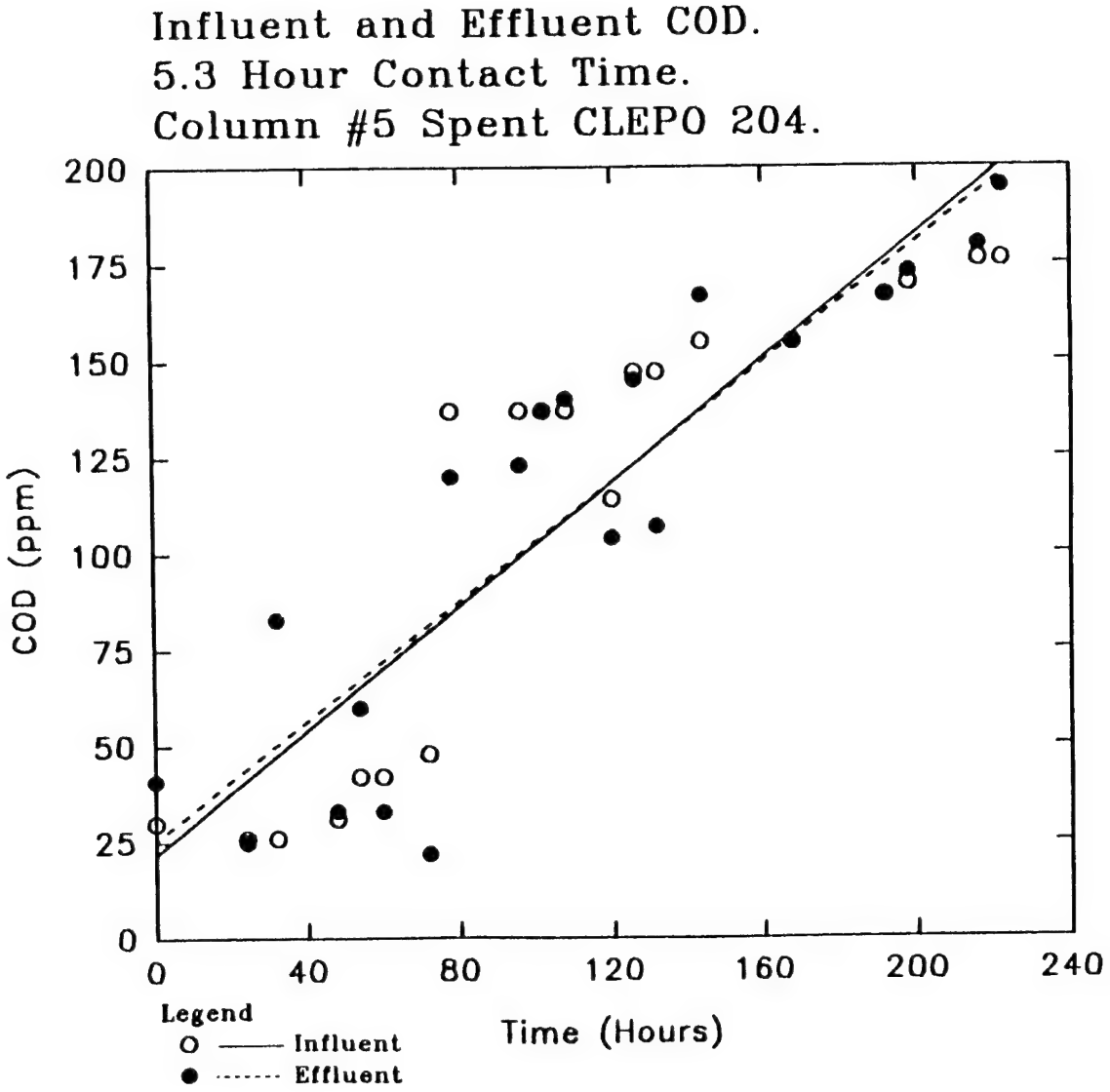


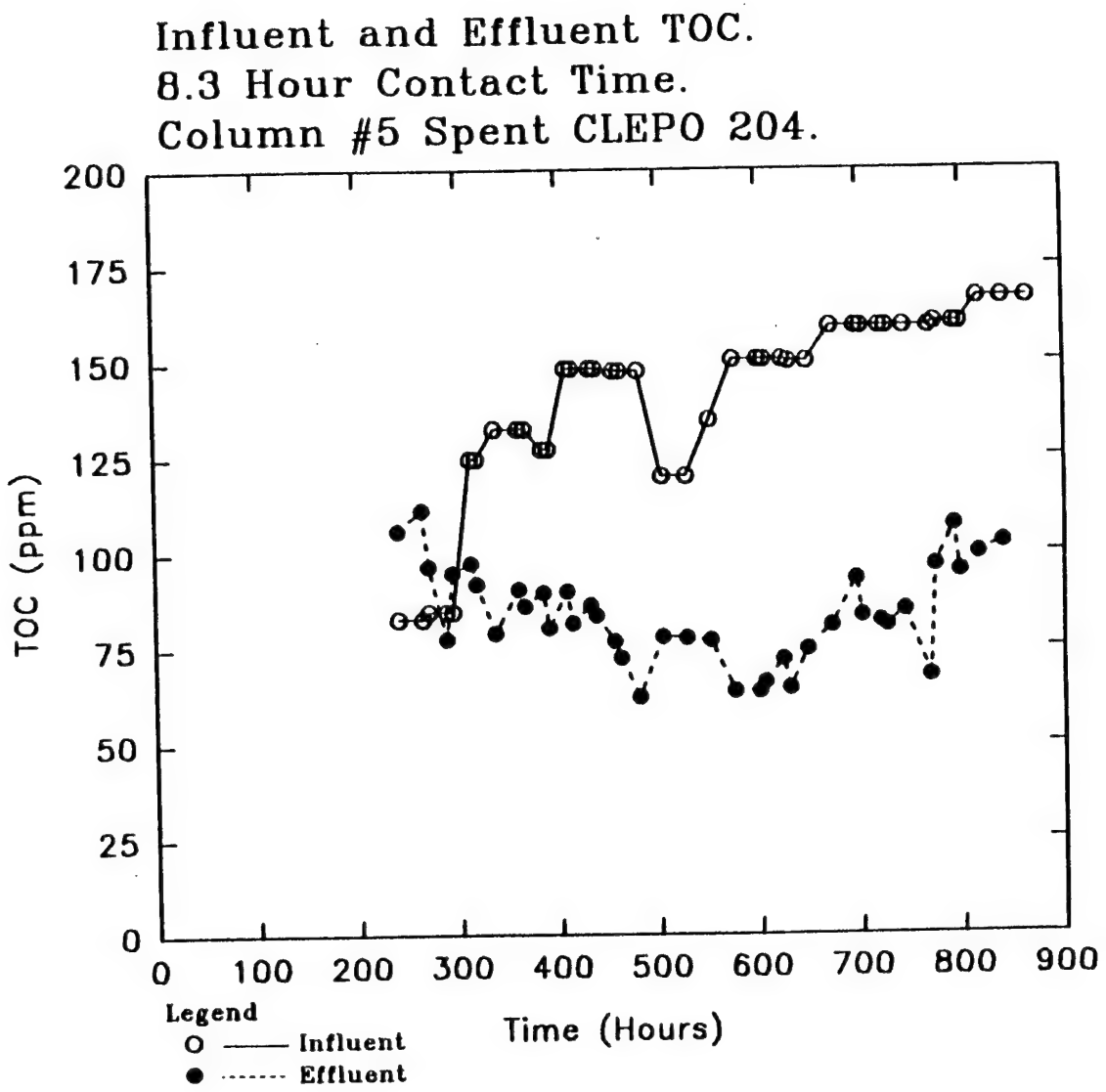

Influent and Effluent Ethylenediamine.
8.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
Ethylenediamine (ppm)
150
125
100
75
50
25
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent TOC.
5.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
TOC (ppm)
200
175
150
125
100
75
50
25
0
0
40
80
120
160
200
240
Time (Hours)
Legend
Influent
Effluent

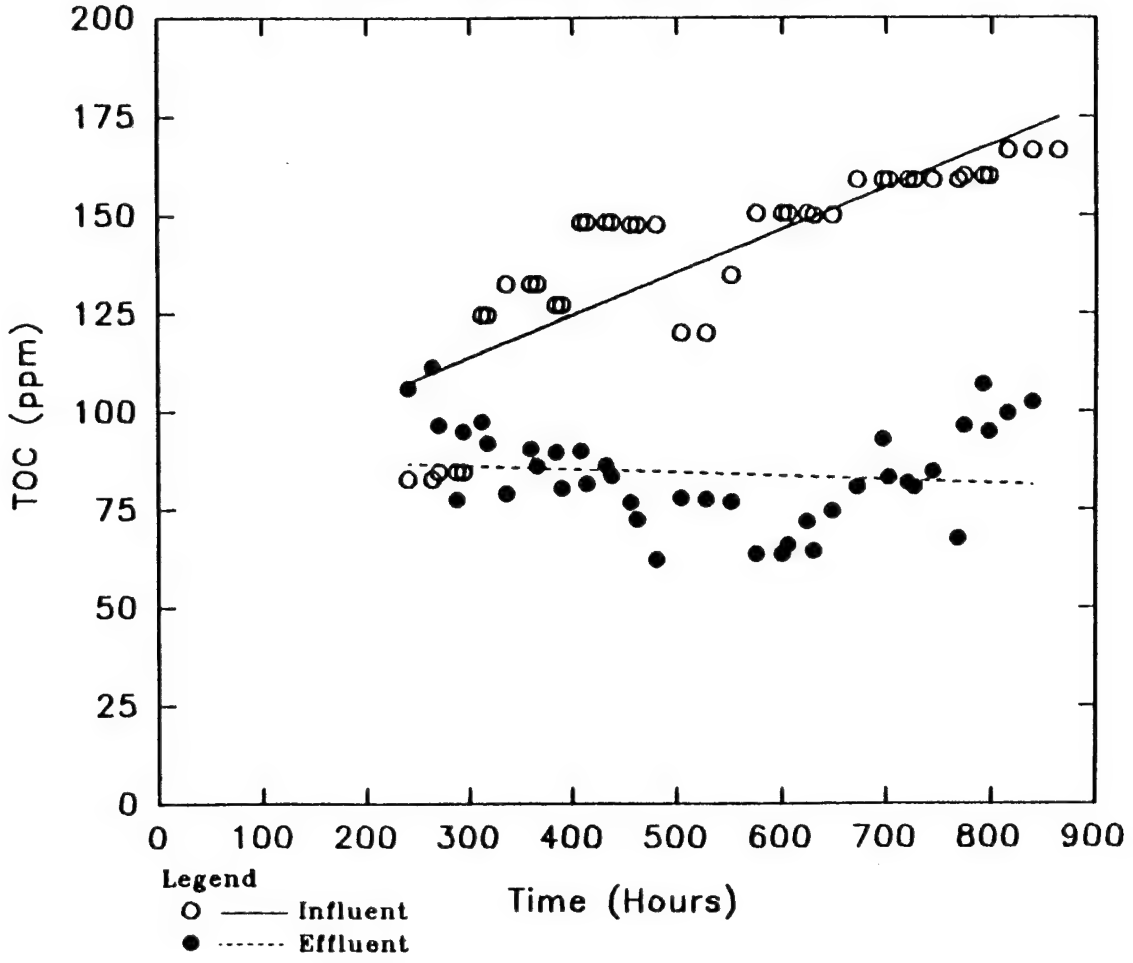

Influent and Effluent TOC.
5.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
TOC (ppm)
200
175
150
125
100
75
50
25
0
0
40
80
120
160
200
240
Time (Hours)
Legend
Influent
Effluent

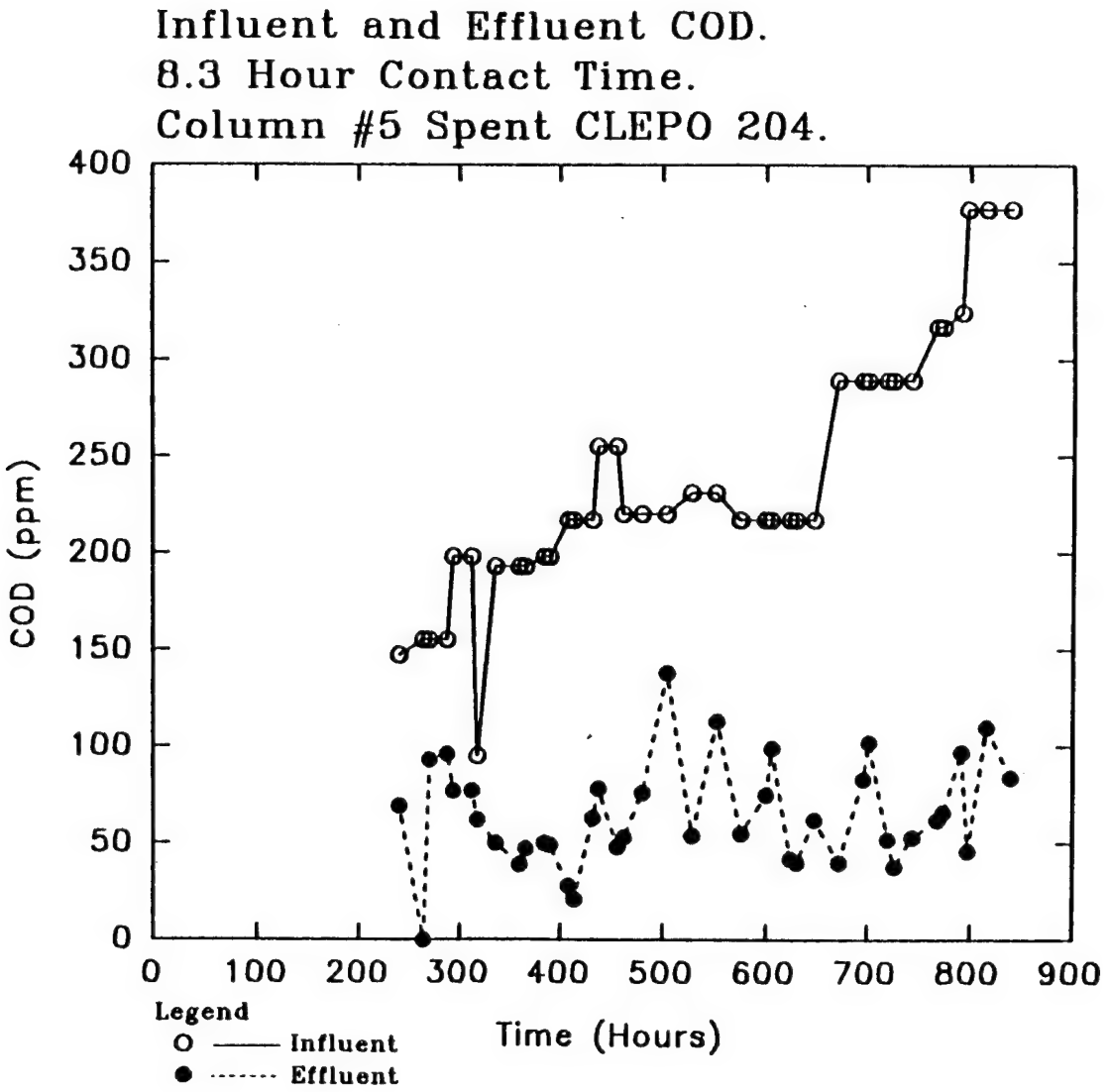

Influent and Effluent COD.
5.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
COD (ppm)
200
175
150
125
100
75
50
25
0
0
40
80
120
160
200
240
Time (Hours)
Legend
Influent
Effluent

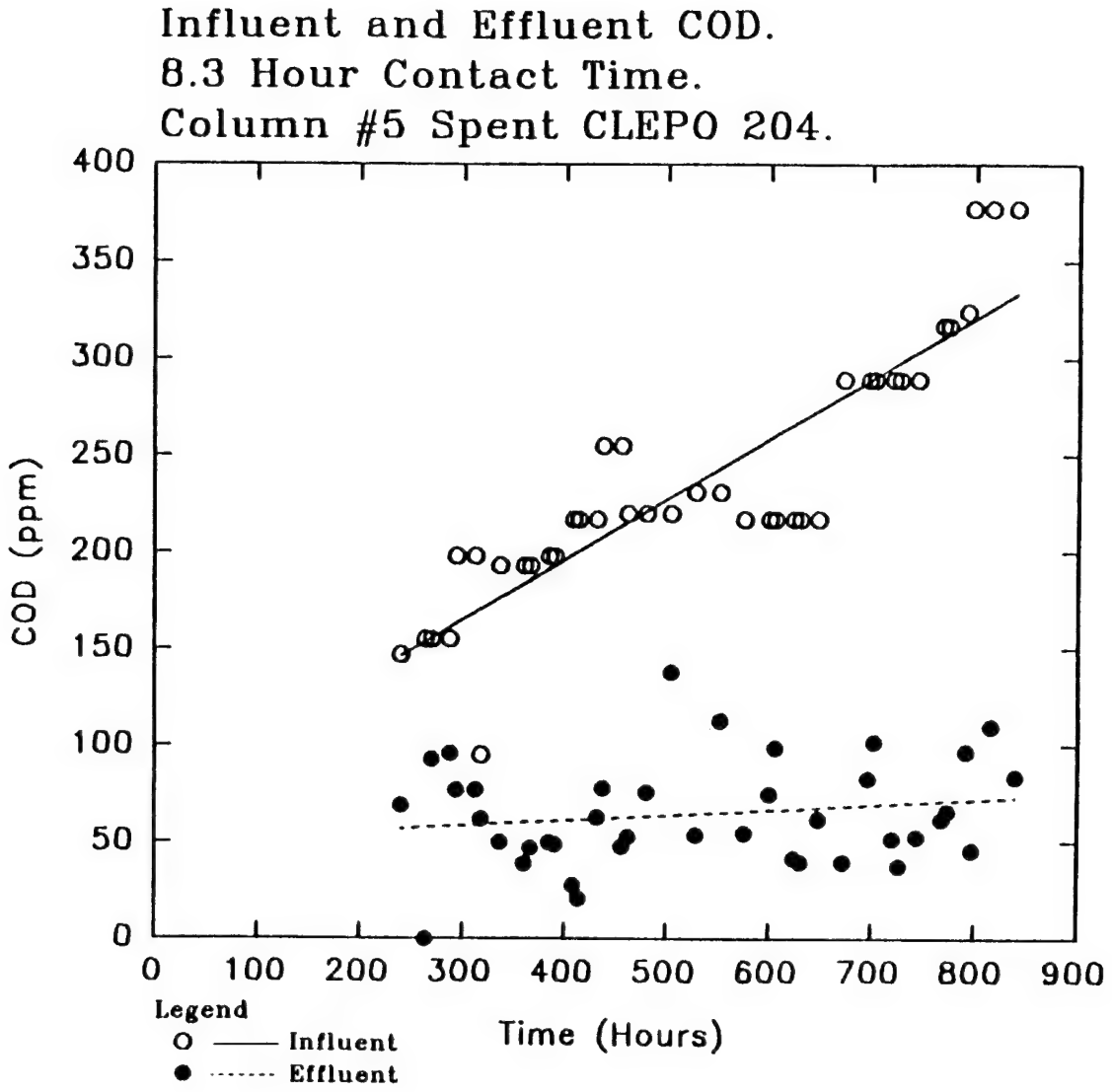

Influent and Effluent COD.
5.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
COD (ppm)
200
175
150
125
100
75
50
25
0
0
40
80
120
160
200
240
Time (Hours)
Legend
Influent
Effluent

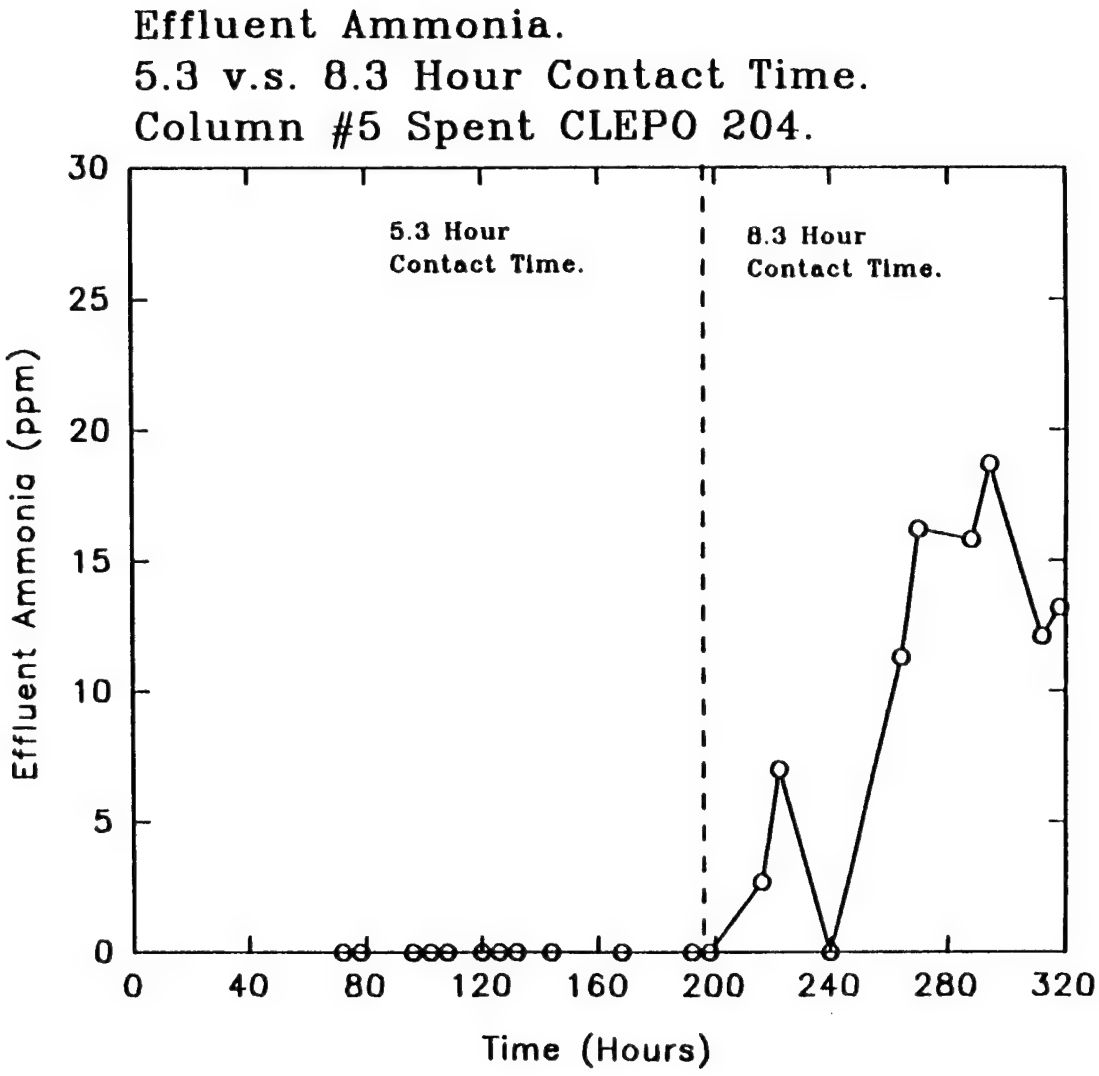

Influent and Effluent TOC.
8.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
TOC (ppm)
200
175
150
125
100
75
50
25
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent

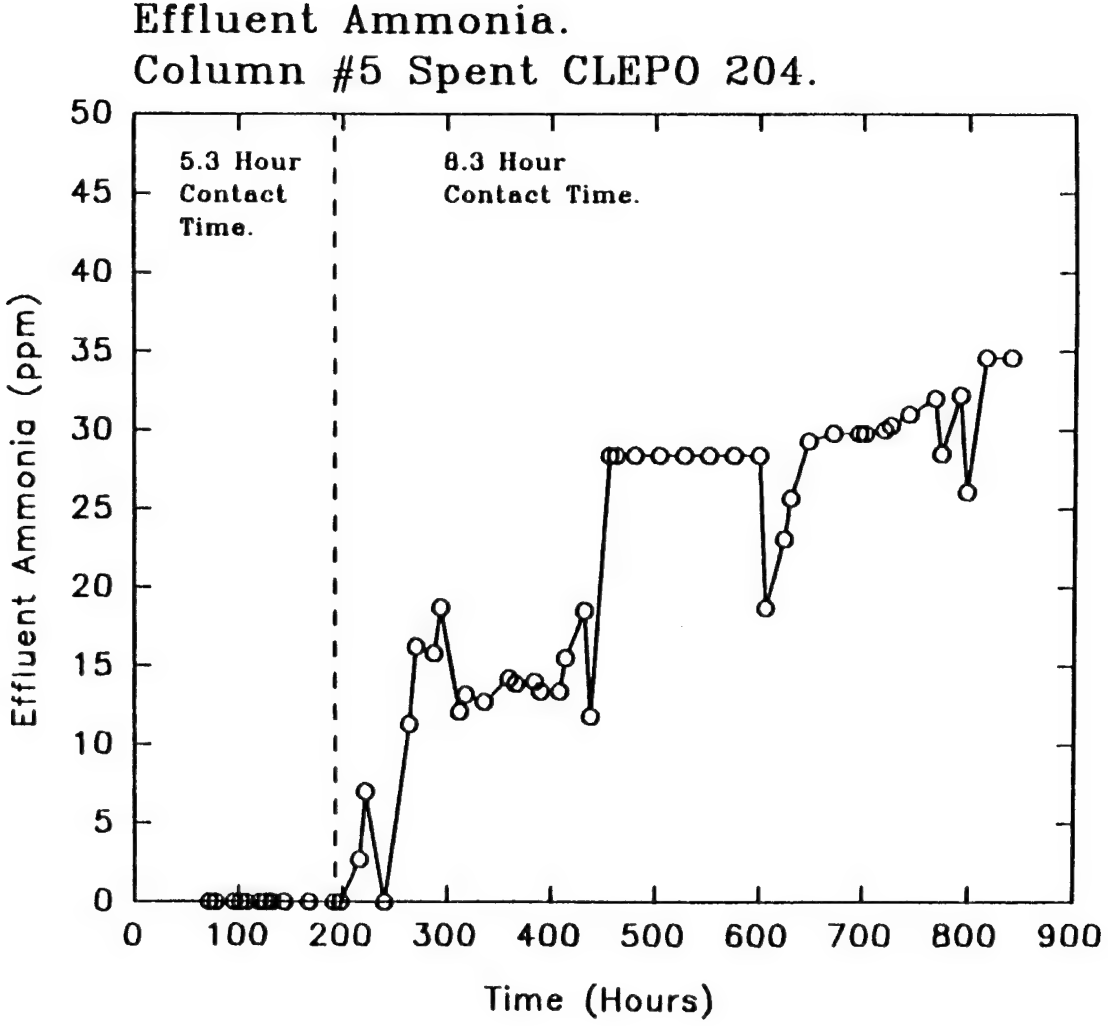
Influent and Effluent TOC.
8.3 Hour Contact Time.
Column #5 Spent CLEPO 204.

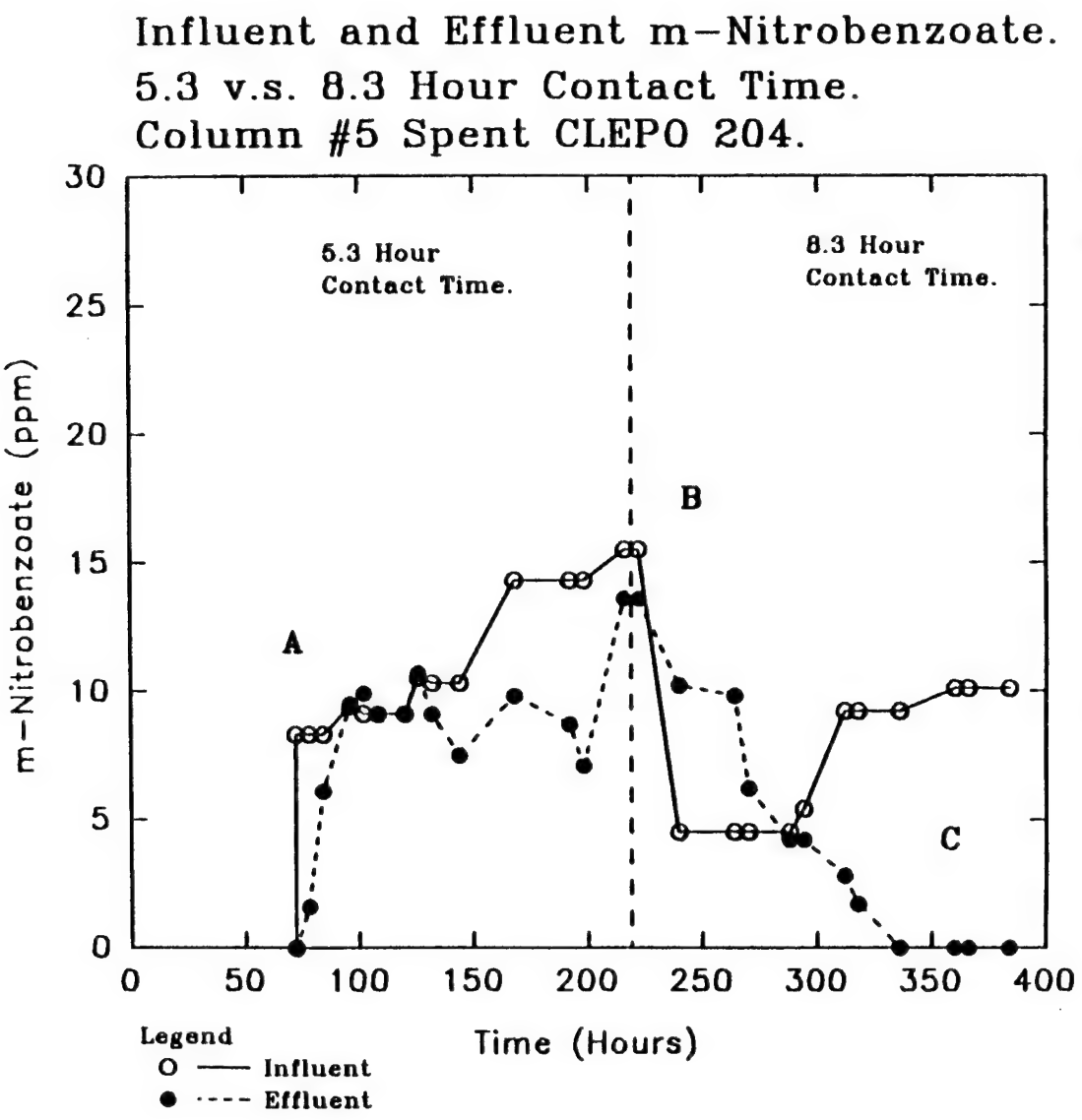



Influent and Effluent COD.
8.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
COD (ppm)
400
350
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent COD.
8.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
COD (ppm)
400
350
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)
Legend
Influent
Effluent


Effluent Ammonia.
5.3 v.s. 8.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
5.3 Hour
Contact Time.
8.3 Hour
Contact Time.
Effluent Ammonia (ppm)
Time (Hours)
0
5
10
15
20
25
30
0
40
80
120
160
200
240
280
320


Effluent Ammonia.
Column #5 Spent CLEPO 204.
5.3 Hour Contact Time.
8.3 Hour Contact Time.
Effluent Ammonia (ppm)
Time (Hours)
0
5
10
15
20
25
30
35
40
45
50
0
100
200
300
400
500
600
700
800
900

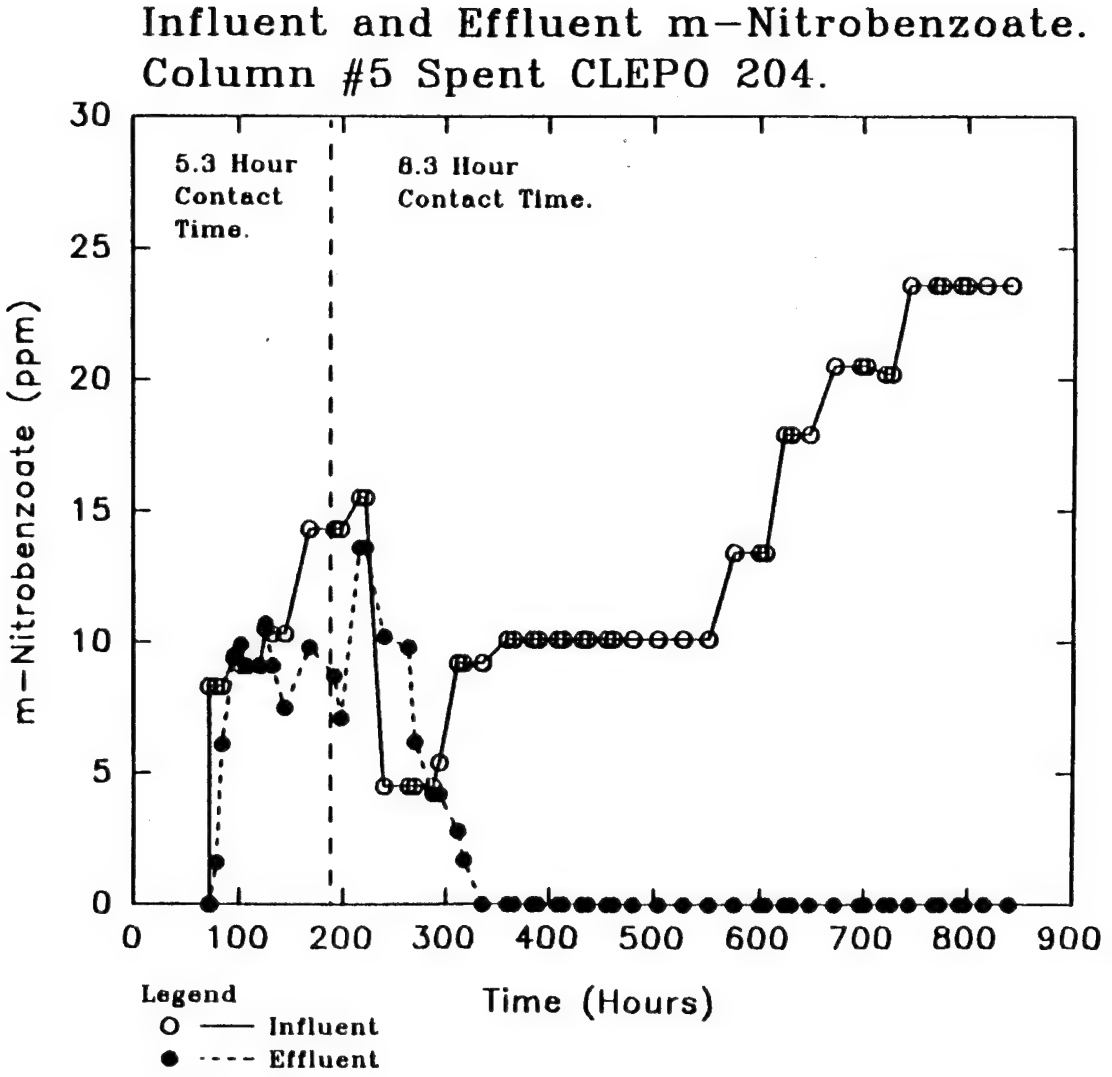


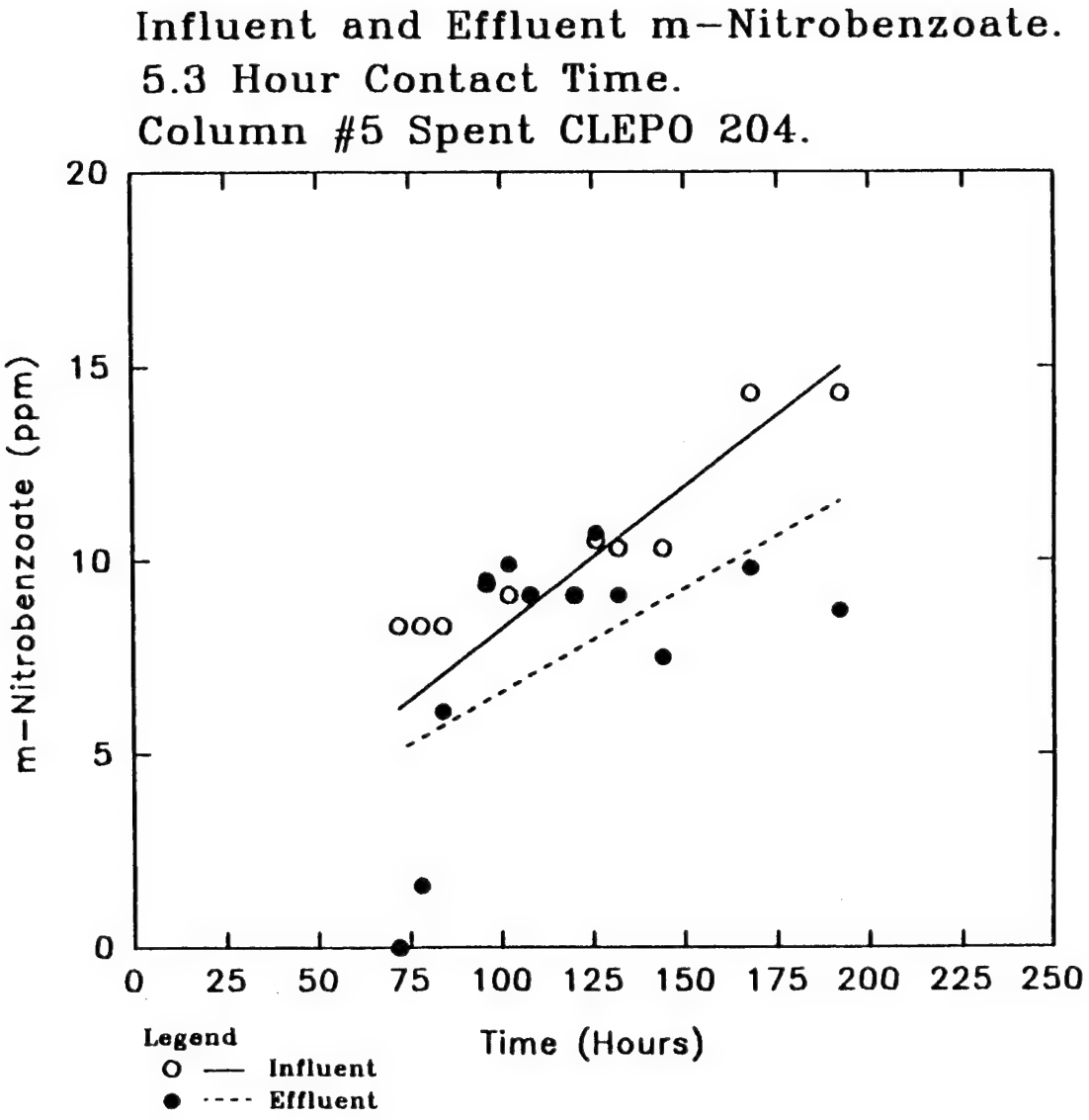
EVENTS:

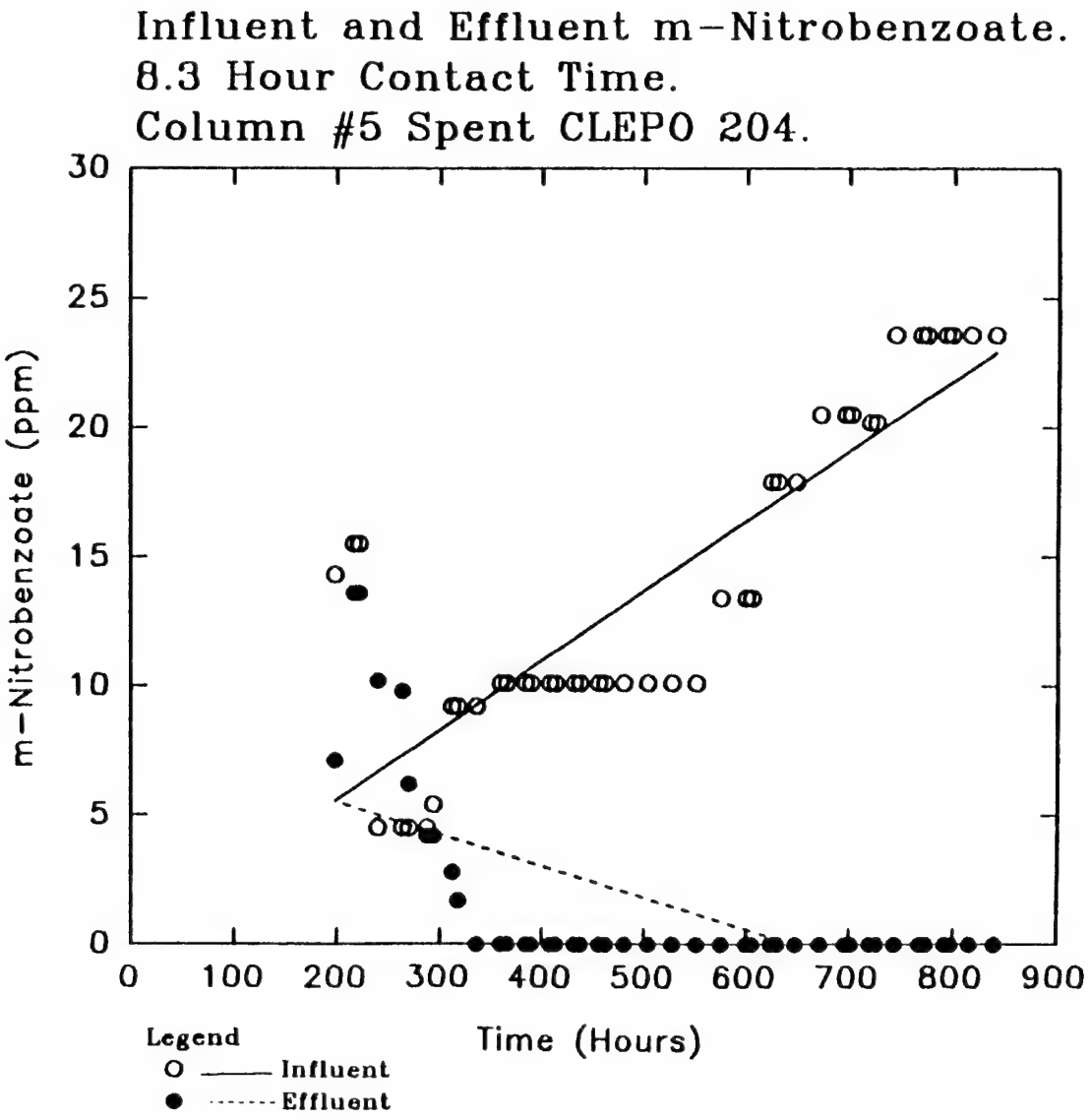
A. At 72 hours the influent was spiked with a spent CLEPO 204 solution which contained 8.3 ppm m-nitrobenzoate.

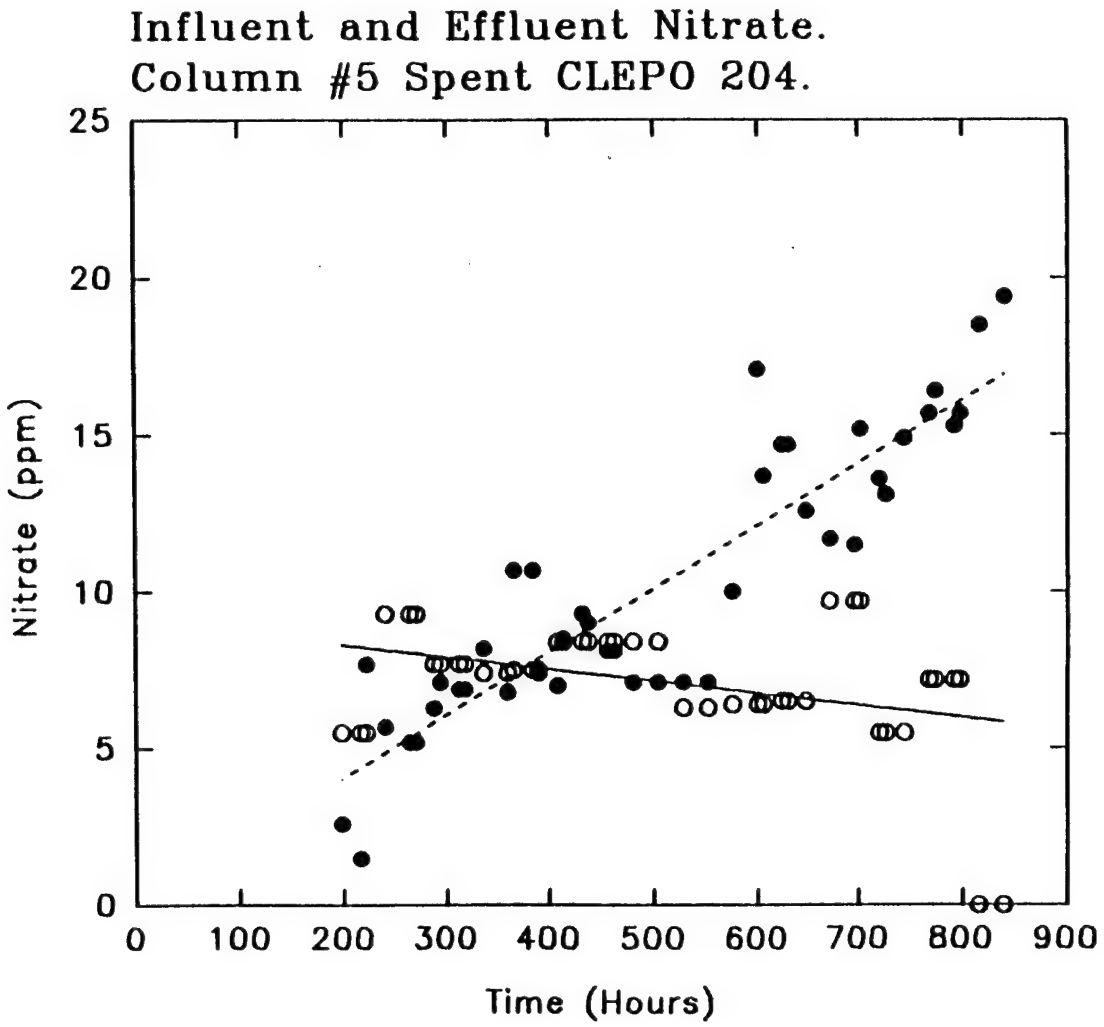
B. At 192 hours the influent flow rate was decreased from 14 mL per minute to 9 mL per minute. This changed the fluid retention time from 5.3 to 8.3 hours.

C. At 336 hours no m-nitrobenzoate could be detected in the effluent.

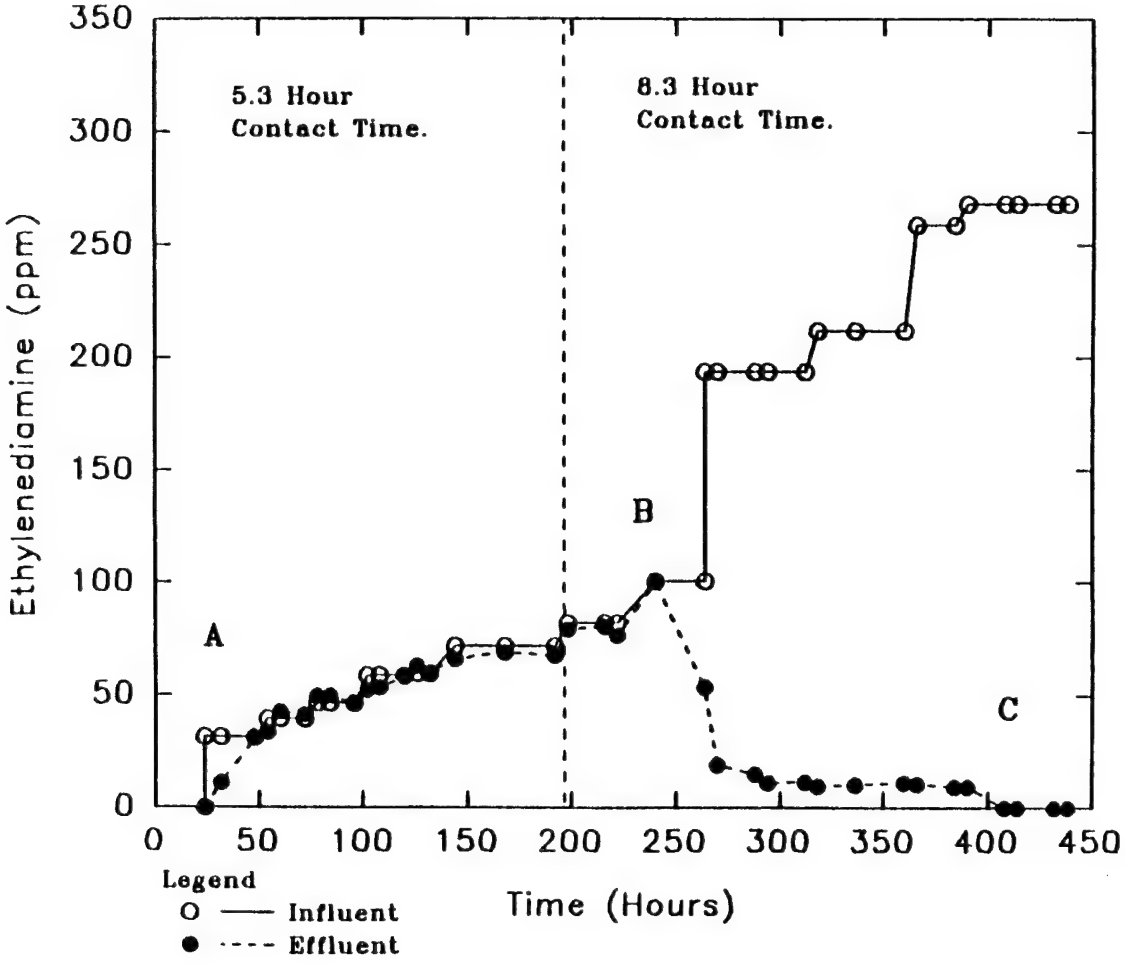

Influent and Effluent m-Nitrobenzoate.
Column #5 Spent CLEPO 204.
5.3 Hour Contact Time.
6.3 Hour Contact Time.
m-Nitrobenzoate (ppm)
Time (Hours)
0
5
10
15
20
25
30
0
100
200
300
400
500
600
700
800
900
Legend
Influent
Effluent


Influent and Effluent m-Nitrobenzoate.
5.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
m-Nitrobenzoate (ppm)
20
15
10
5
0
0
25
50
75
100
125
150
175
200
225
250
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent m-Nitrobenzoate.
8.3 Hour Contact Time.
Column #5 Spent CLEPO 204.
m-Nitrobenzoate (ppm)
Time (Hours)
0
5
10
15
20
25
30
0
100
200
300
400
500
600
700
800
900
Legend
Influent
Effluent


Influent and Effluent Nitrate.
Column #5 Spent CLEPO 204.
Nitrate (ppm)
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
Time (Hours)

Influent and Effluent Ethylenediamine. 5.3 v.s. 8.3 Hour Contact Time. Column #6.



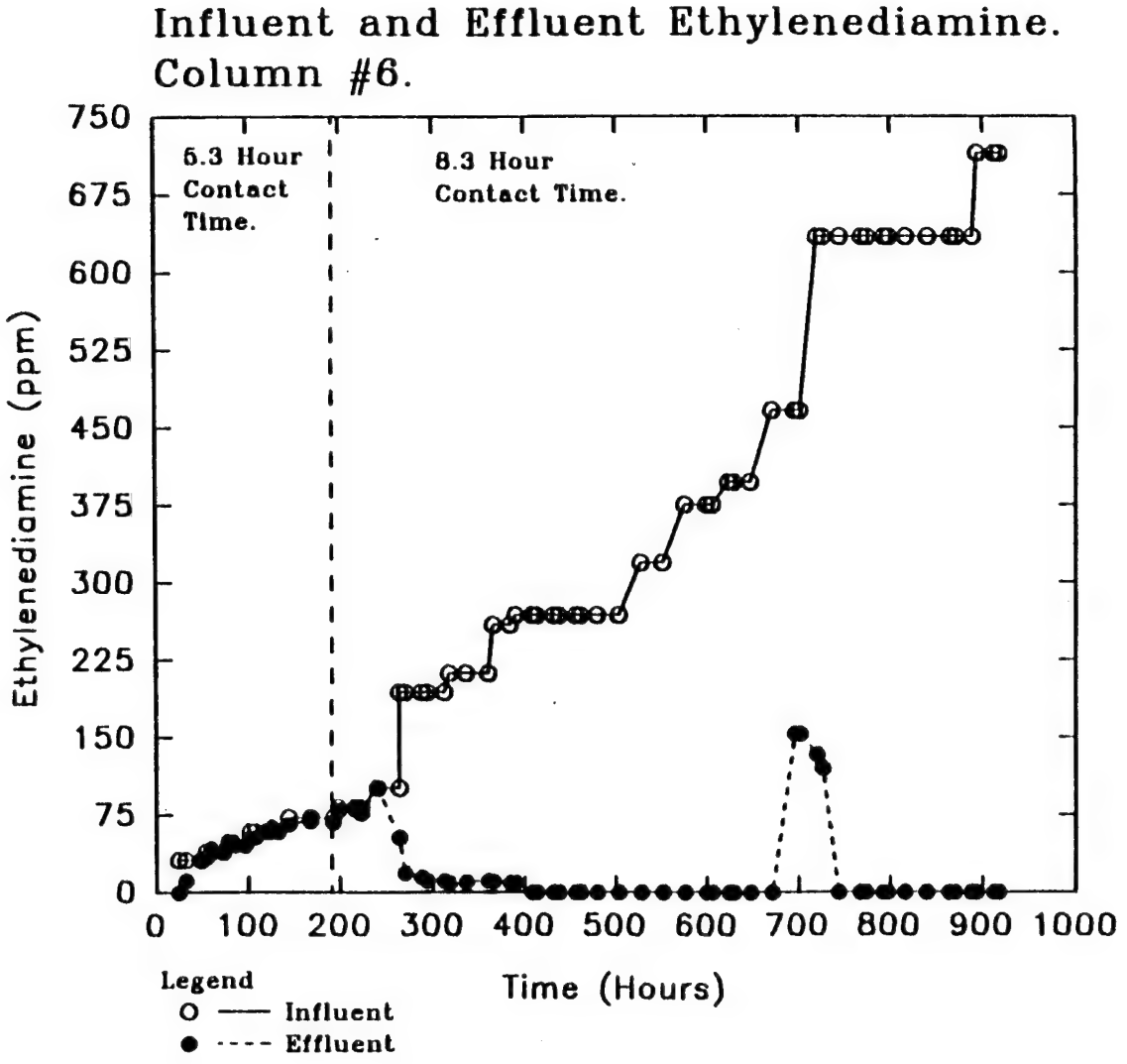
EVENTS:

A. At 24 hours the influent was spiked with 31.2 ppm ethylenediamine.

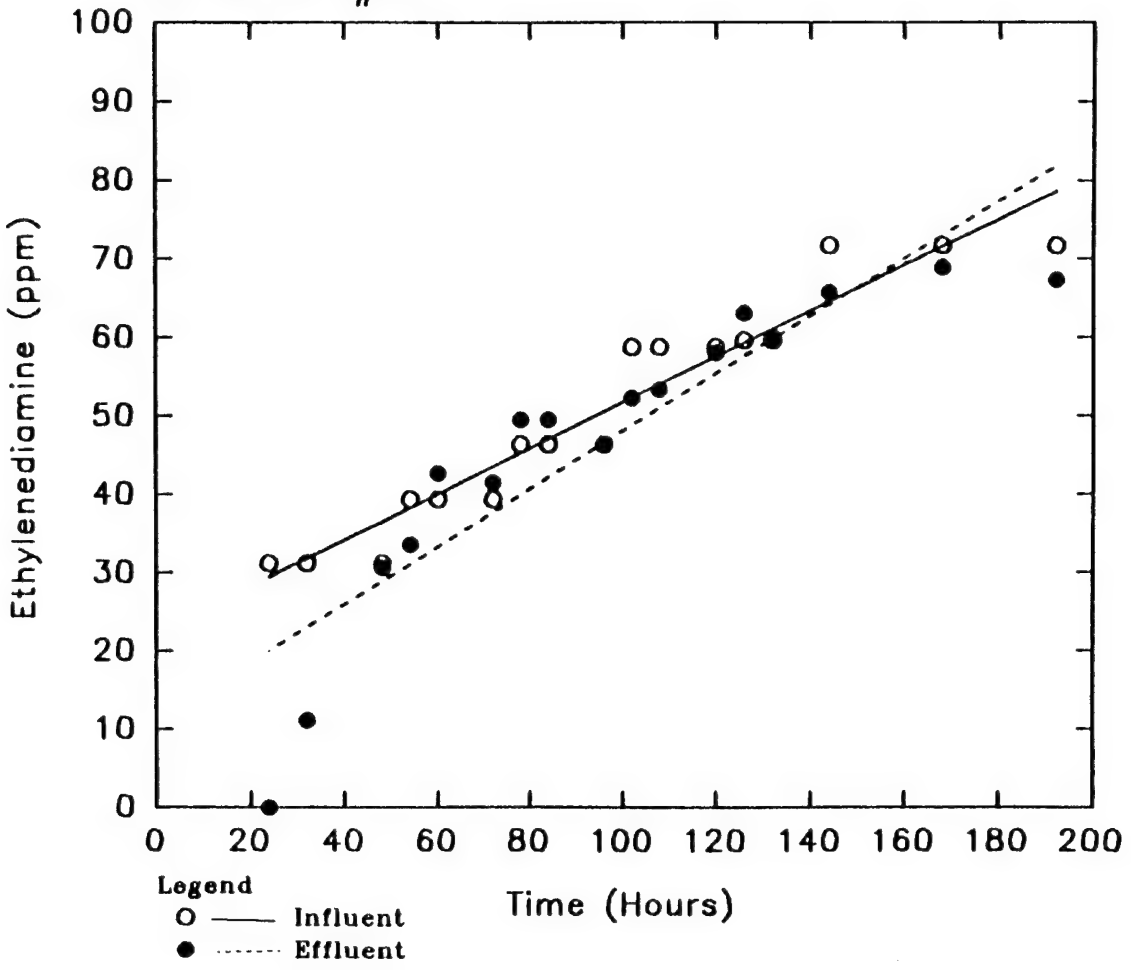
B. At 192 hours the influent flow rate was decreased from 14 mL per minute to 9 mL per minute. This changed the retention time from 5.3 hours to 8.3 hours.

C. At 264 hours the effluent ethylenediamine begins to drop off.

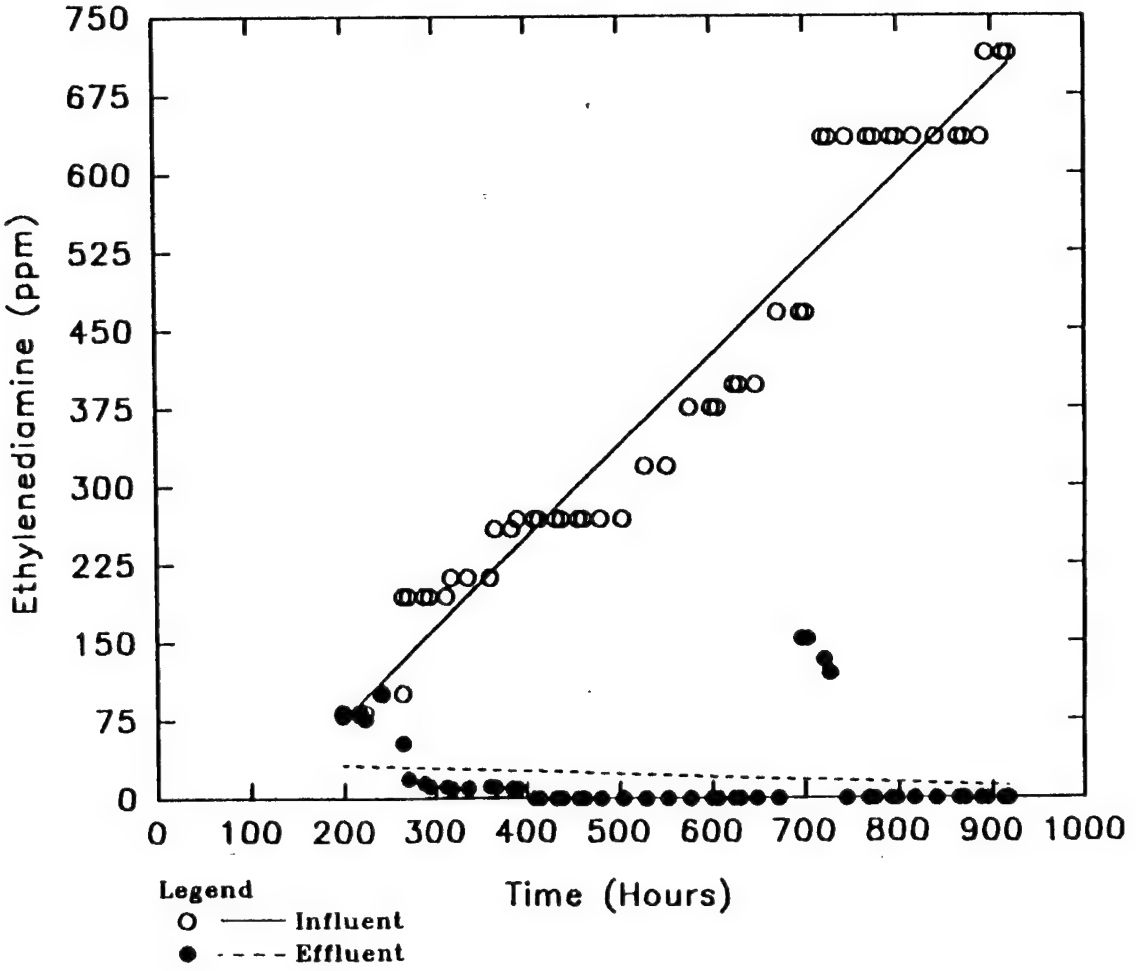
At 408 hours the effluent ethylenediamine concentration is zero.

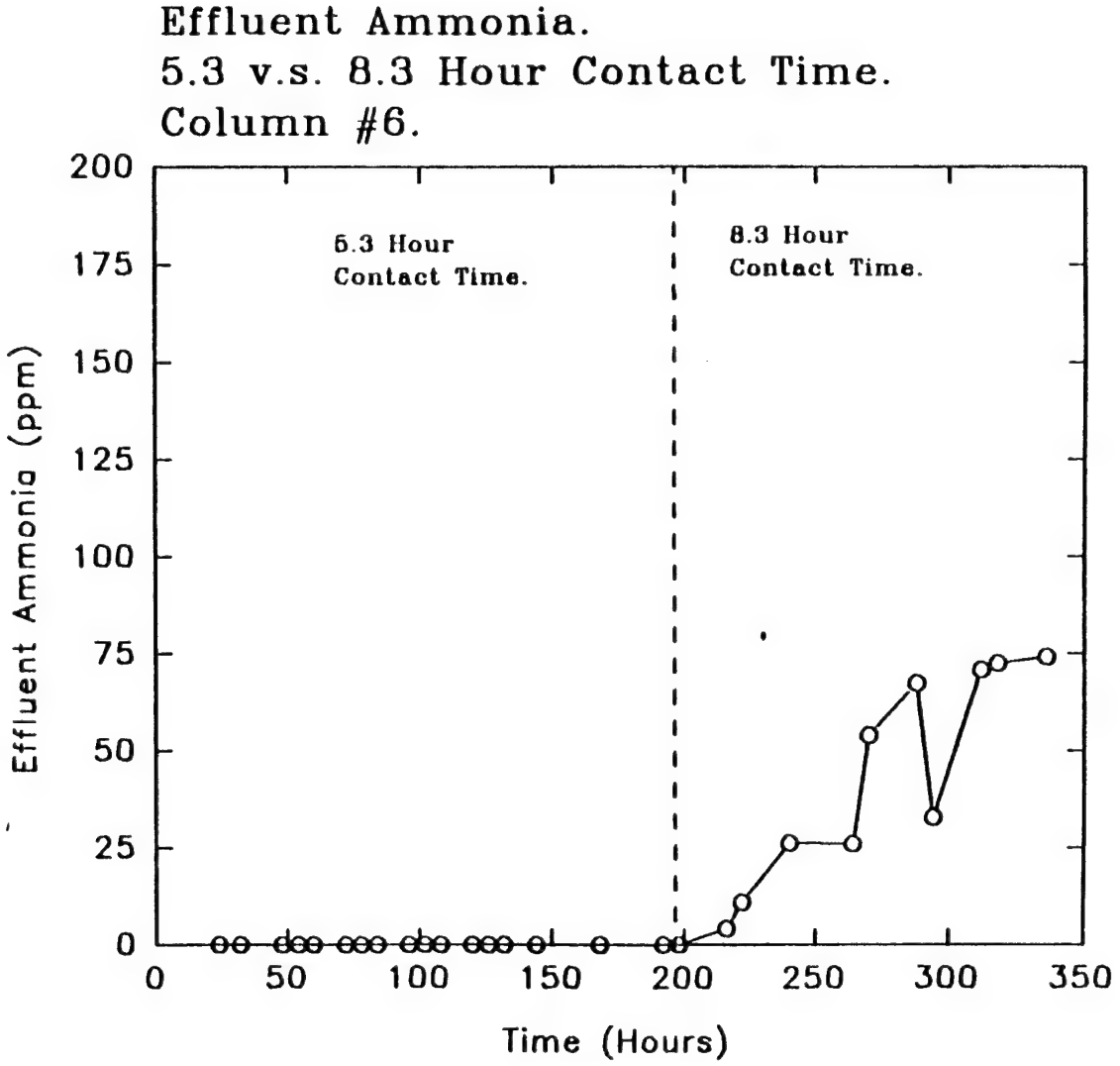

Influent and Effluent Ethylenediamine.
Column #6.
5.3 Hour
Contact
Time.
8.3 Hour
Contact Time.
Ethylenediamine (ppm)
750
675
600
525
450
375
300
225
150
75
0
0
100
200
300
400
500
600
700
800
900
1000
Time (Hours)
Legend
Influent
Effluent

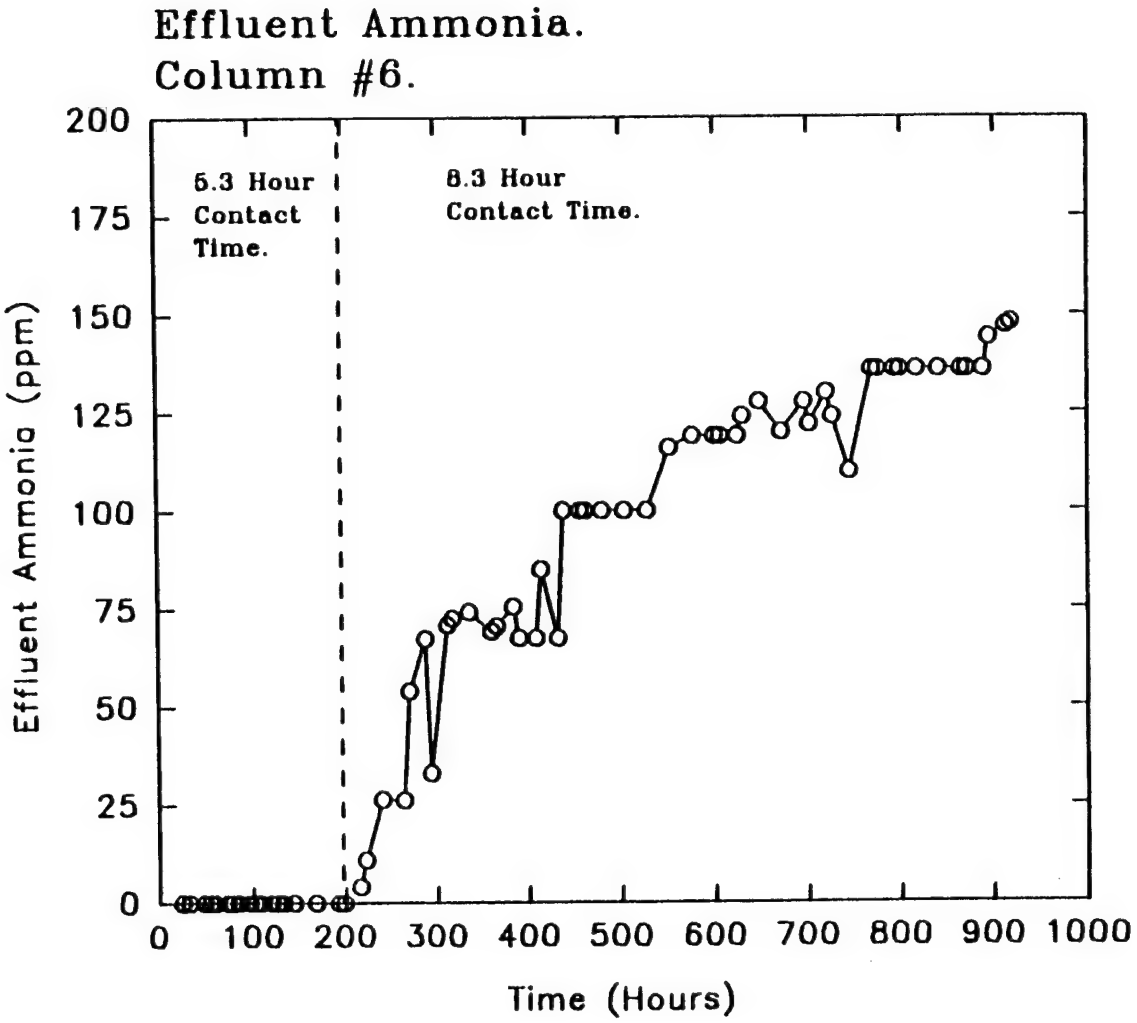
Influent and Effluent Ethylenediamine.
5.3 Hour Contact Time.
Column #6.

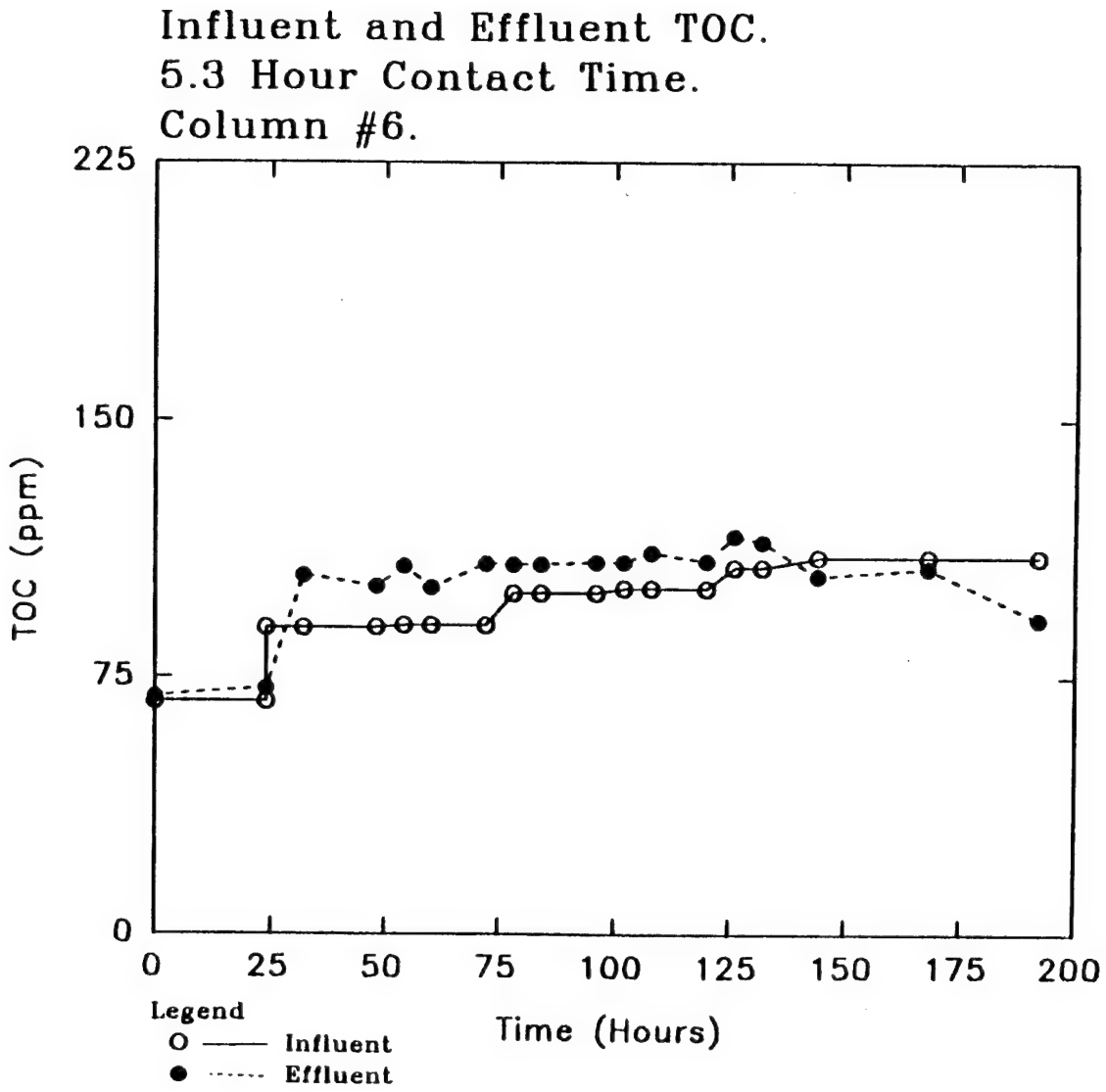


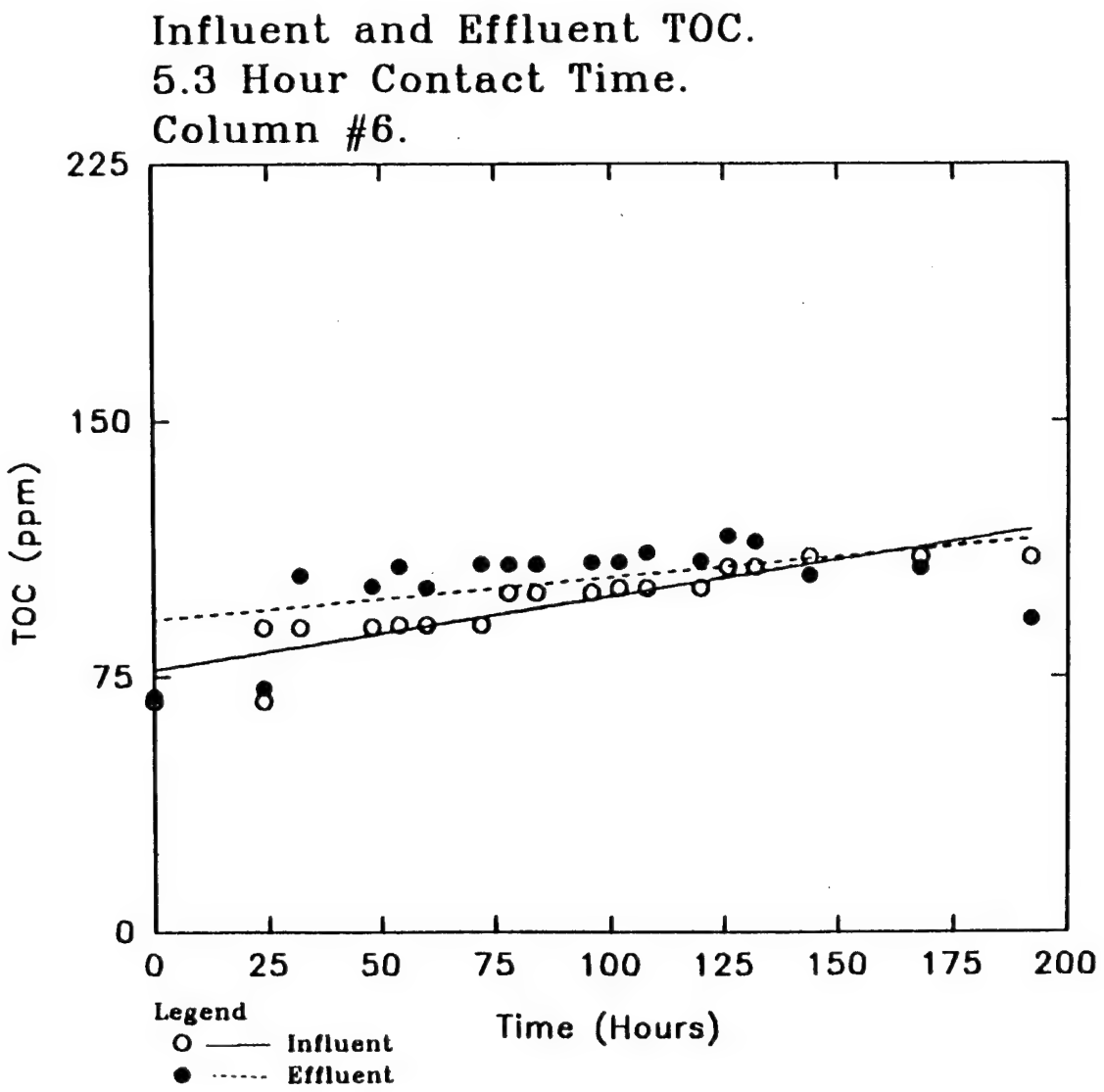
Influent and Effluent Ethylenediamine.
8.3 Hour Contact Time.
Column #6.

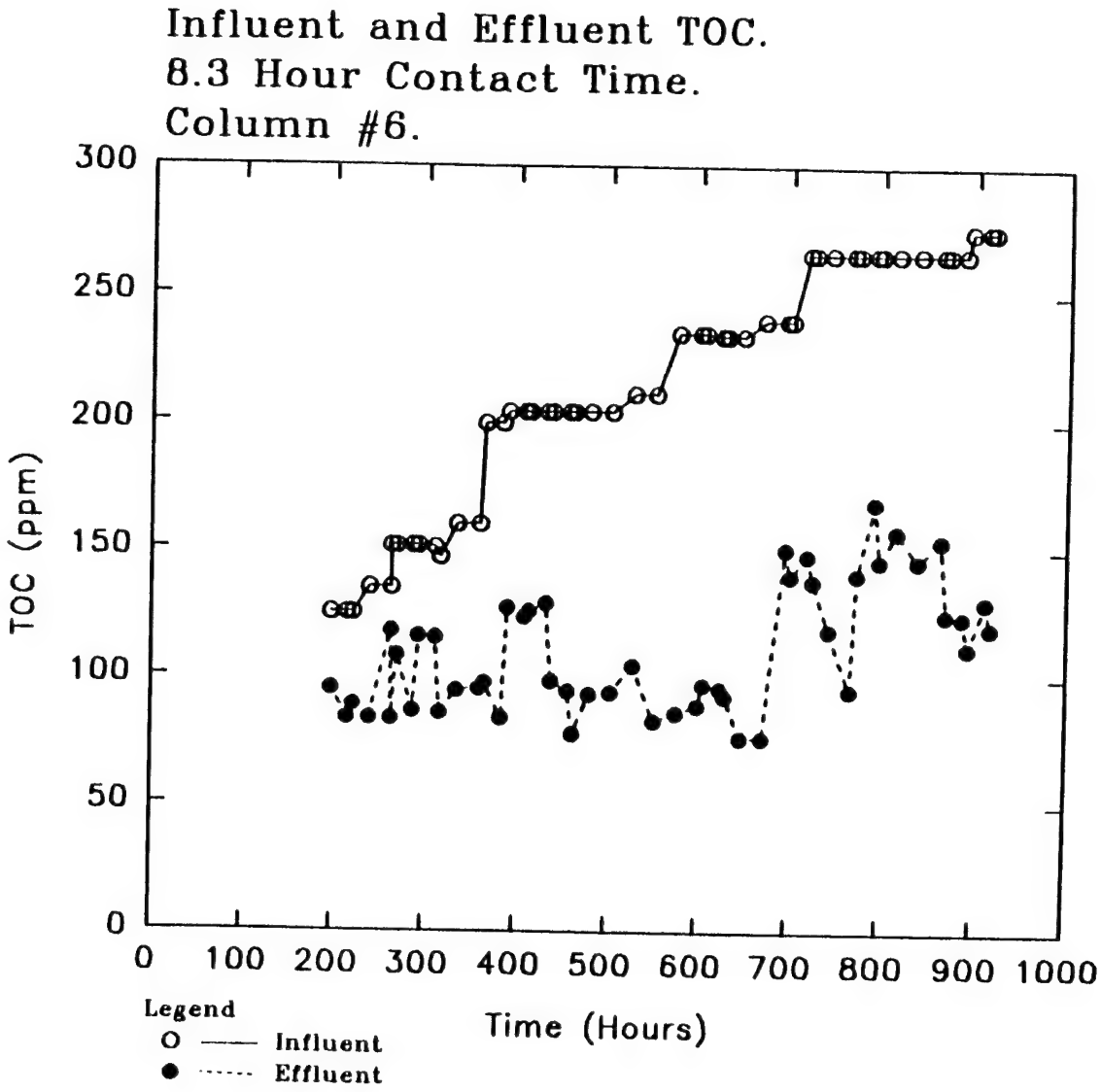


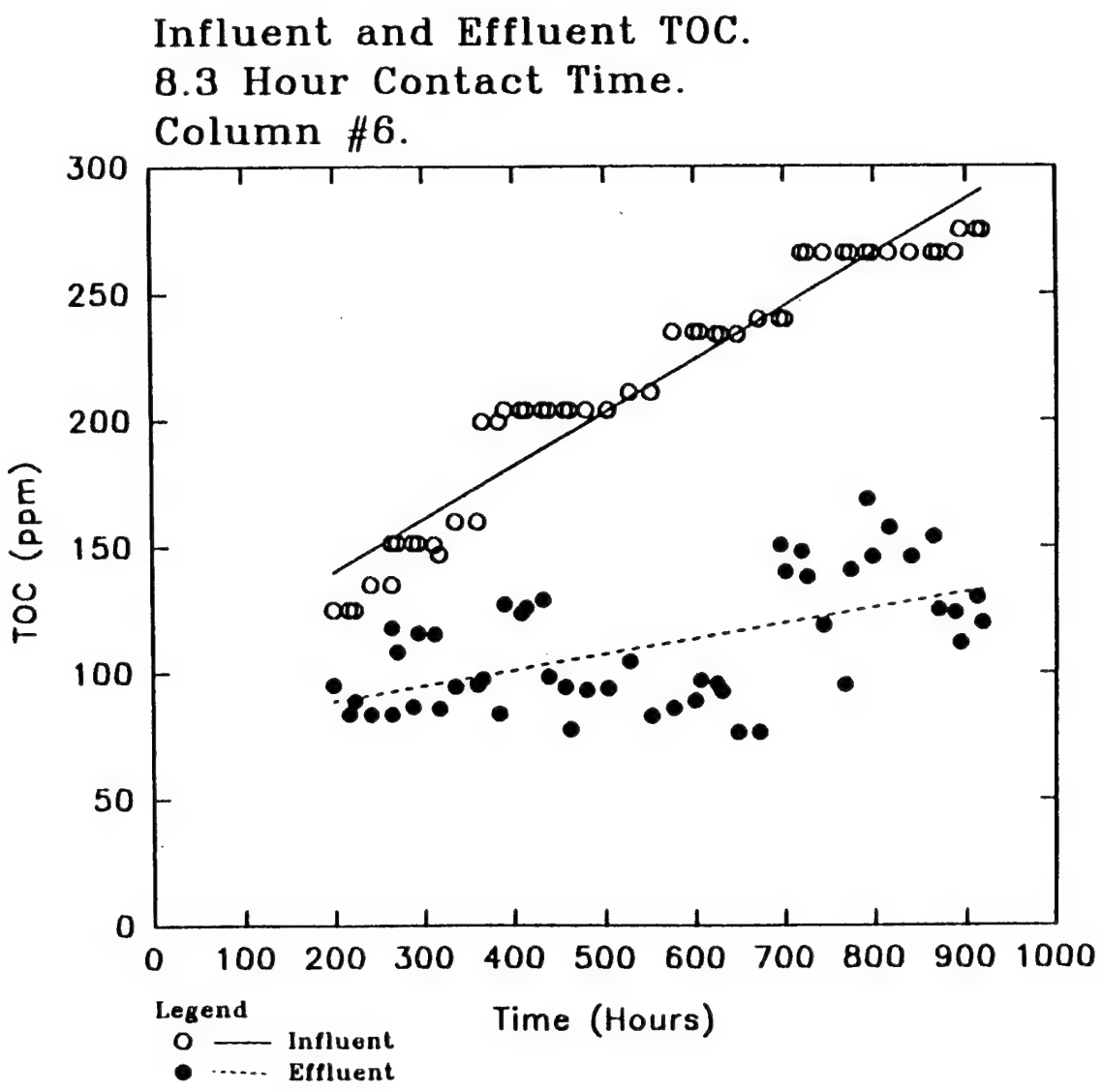

Effluent Ammonia.
5.3 v.s. 8.3 Hour Contact Time.
Column #6.
5.3 Hour
Contact Time.
8.3 Hour
Contact Time.
Effluent Ammonia (ppm)
200
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
Time (Hours)

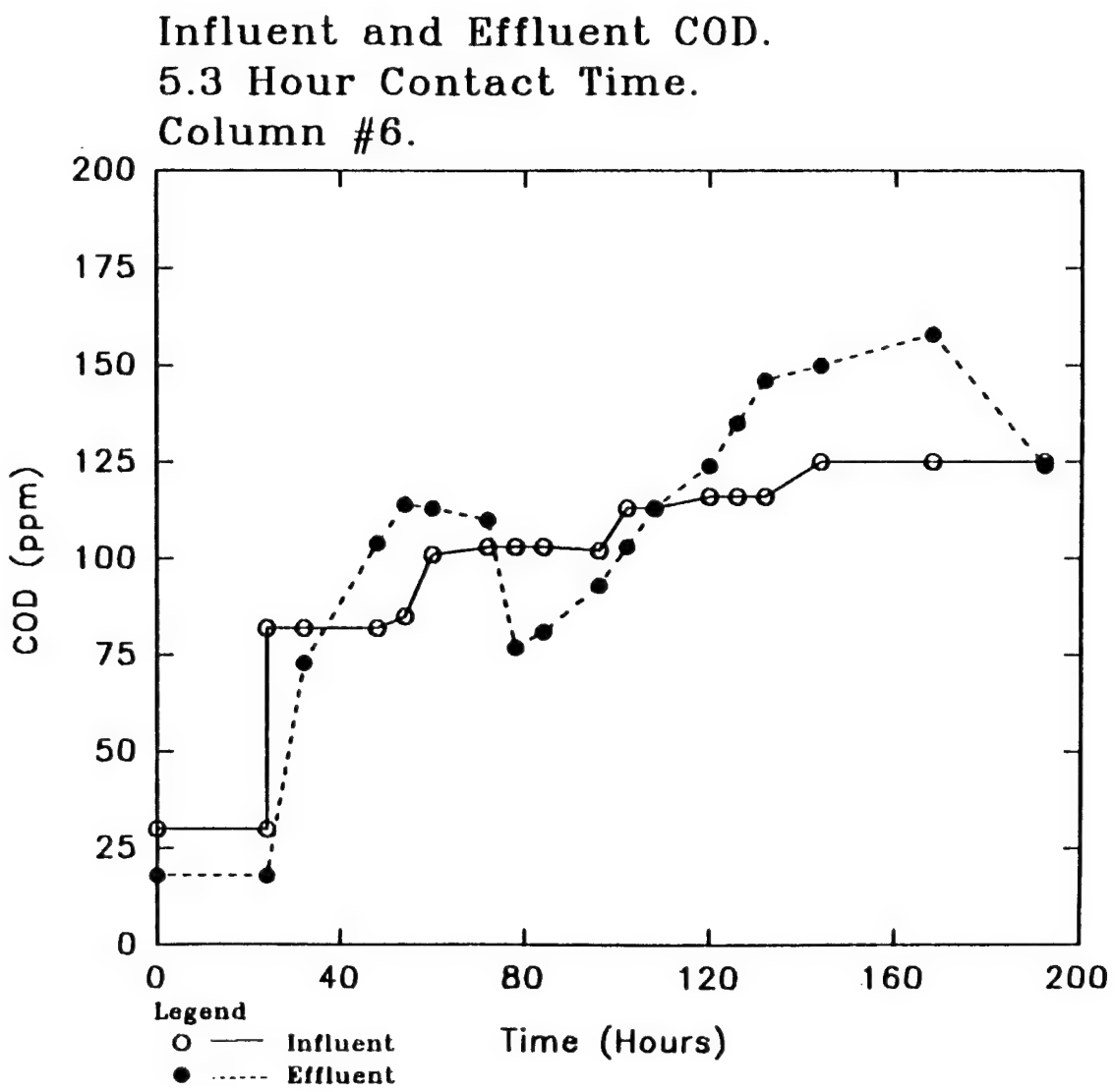

Effluent Ammonia.
Column #6.
5.3 Hour
Contact
Time.
8.3 Hour
Contact Time.
Effluent Ammonia (ppm)
200
175
150
125
100
75
50
25
0
0
100
200
300
400
500
600
700
800
900
1000
Time (Hours)


Influent and Effluent TOC.
5.3 Hour Contact Time.
Column #6.
225
150
75
0
TOC (ppm)
0
25
50
75
100
125
150
175
200
Time (Hours)
Legend
Influent
Effluent

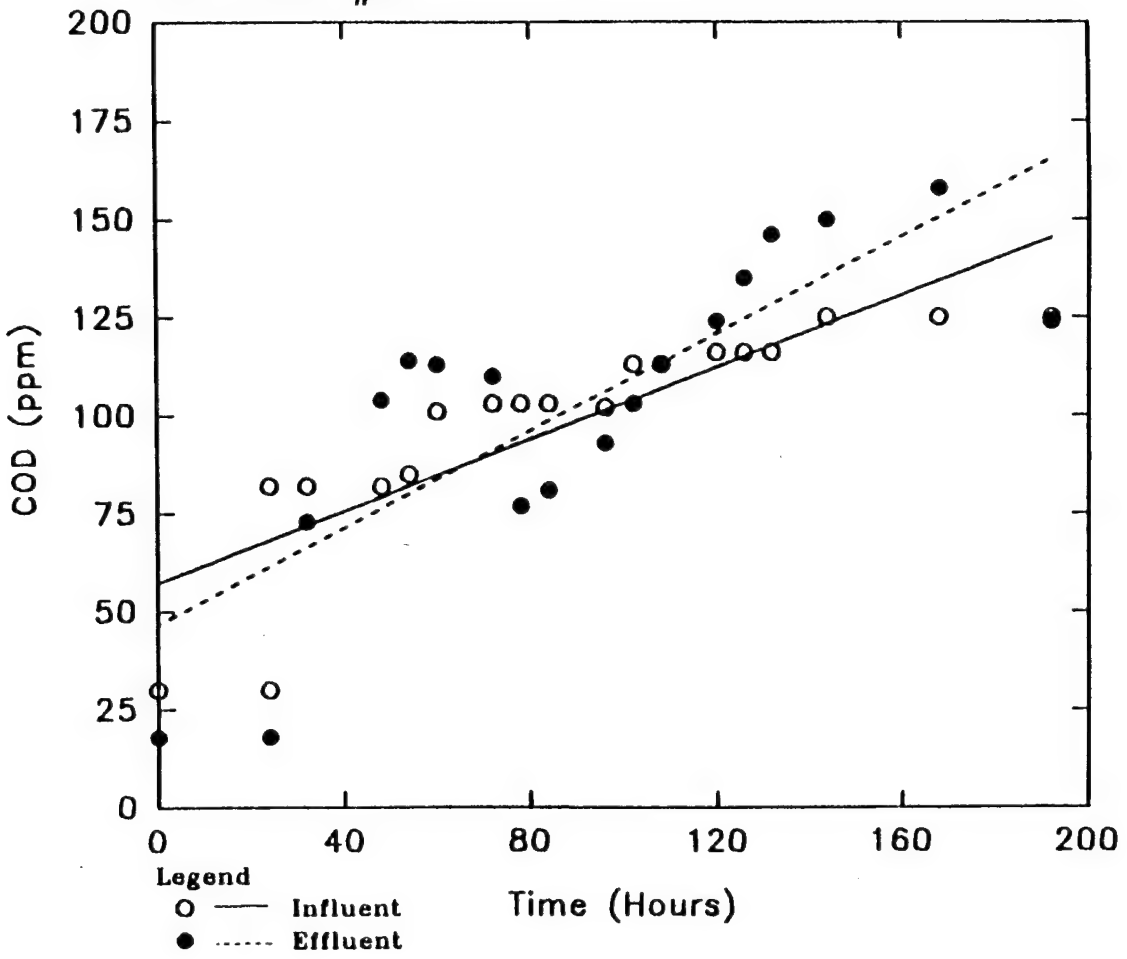

Influent and Effluent TOC.
5.3 Hour Contact Time.
Column #6.
225
150
75
0
TOC (ppm)
0
25
50
75
100
125
150
175
200
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent TOC.
8.3 Hour Contact Time.
Column #6.
TOC (ppm)
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
1000
Time (Hours)
Legend
Influent
Effluent

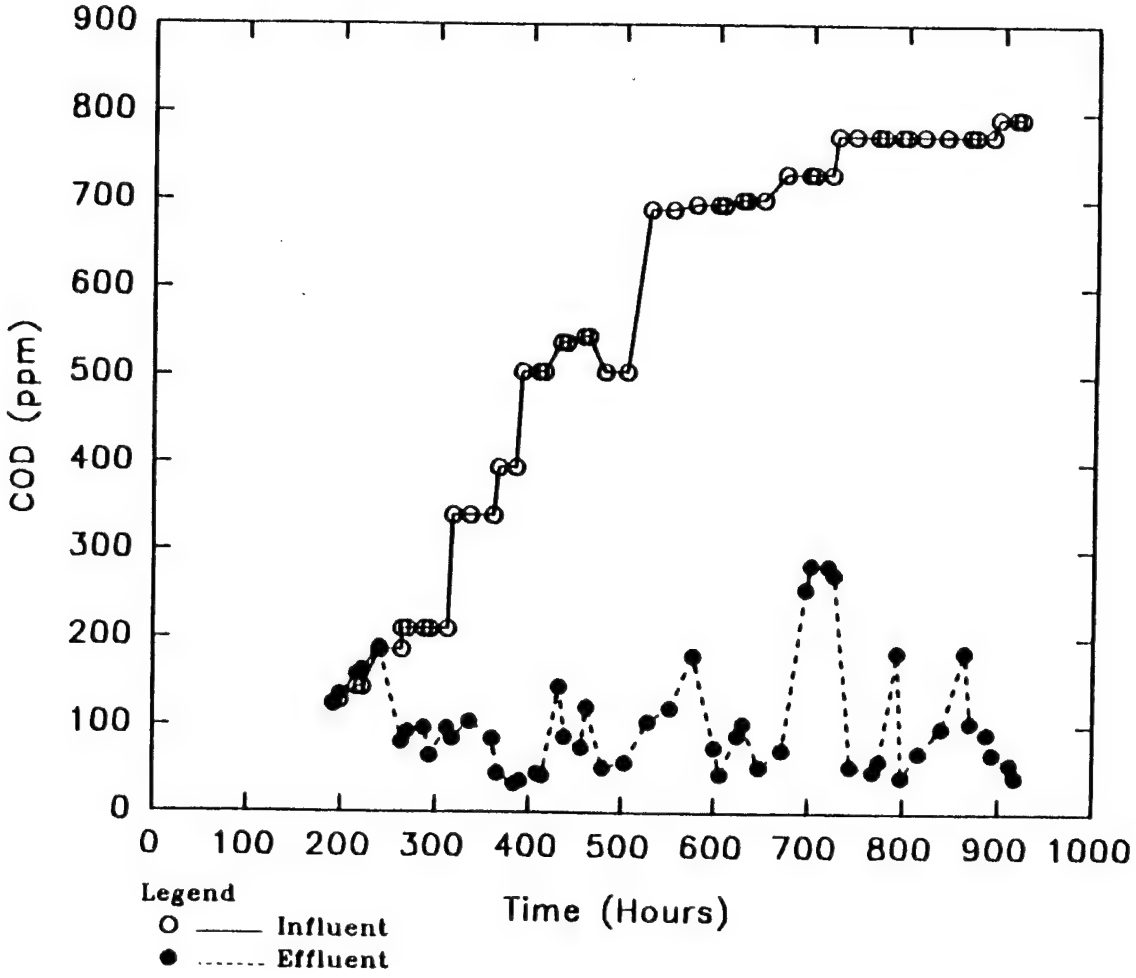

Influent and Effluent TOC.
8.3 Hour Contact Time.
Column #6.
TOC (ppm)
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
1000
Time (Hours)
Legend
Influent
Effluent


Influent and Effluent COD.
5.3 Hour Contact Time.
Column #6.
COD (ppm)
200
175
150
125
100
75
50
25
0
0
40
80
120
160
200
Time (Hours)
Legend
Influent
Effluent

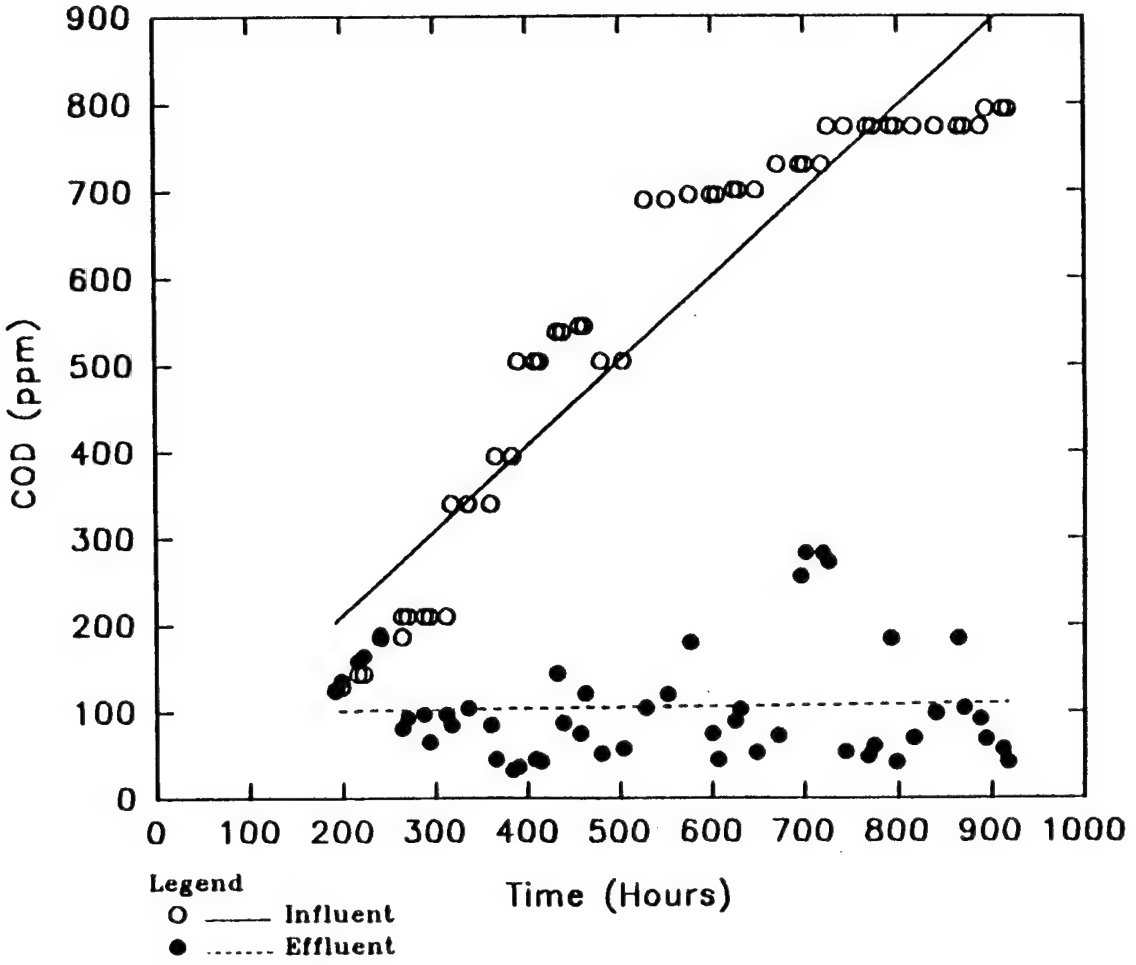
Influent and Effluent COD.
5.3 Hour Contact Time.
Column #6.



Influent and Effluent COD.
8.3 Hour Contact Time.
Column #6.



Influent and Effluent COD.
8.3 Hour Contact Time.
Column #6.



APPENDIX K

AIR FORCE DOCUMENTS AND AFTO 22 FORMS

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SAN ANTONIO AIR LOGISTICS CENTER (AFLC)
KELLY AIR FORCE BASE, TEXAS 78241-5000

REPLY TO
ATTN OF: Kurt Greebon (LPPTAH) & Ray Martinez (EG&G Idaho, Inc.)

SUBJECT: Non-Cyanide Nickel Strippers

TO:
Gary L. Herrin
Karen Solari
In Turn

1. A request by Karen Solari was made to determine whether or not the non-cyanide nickel strippers will strip the various electroless coatings which might be scheduled for use in the SA-ALC Plating Shop. These coatings consist of the following:

a. The nickel-boron coating that Pratt and Whitney Engine Mfg. originally planned to use.

b. The Nibron, a nickel-boron coating sold by the Pure Coatings, Inc. has been selected for use in lieu of the above coating by Pratt-Whitney and the Air Force.

c. The two proprietary coatings, Niklad 797 and Enplate Ni 425, electroless nickel compounds which Nancy Stapper prototyped and selected as possible replacement for the presently used generic electroless nickel compound.

2. This testing had not been completed because test panels with the Niklad 797 coatings were not available until late September. The results obtained for the various coating is as follows and are graphically illustrated on attachment No.1 and 2.

a. The Pratt-Whitney nickel-boron coating was found to be easily removed (stripped) by several strippers. The results revealed that the Clepo 204 and the EG&G generic formulation are best suited for this stripping application.

b. The Nibron, nickel-boron electroless coating sold by the Pure Coatings, Inc. is also best removed by the Clepo 204 and the EG&G generic formulation.

c. The Niklad 797 electroless nickel coating was found to be removed best by the EG&G generic formulation and the Metalx B-9 strippers. The stripping rate test results for the Enplate Ni425 revealed that none of the non-acid/ non-cyanide strippers nor the cyanide nickel stripper were able to remove this coating at an acceptable production rate.

3. Based on information obtained from Nancy Stapper, Pratt-Whitney engineers involved with the testing of the Niklad 797 are very impressed with their test results on this electroless nickel coating. Their initial test results are so encouraging that they are considering its use for the nickel boron applications.

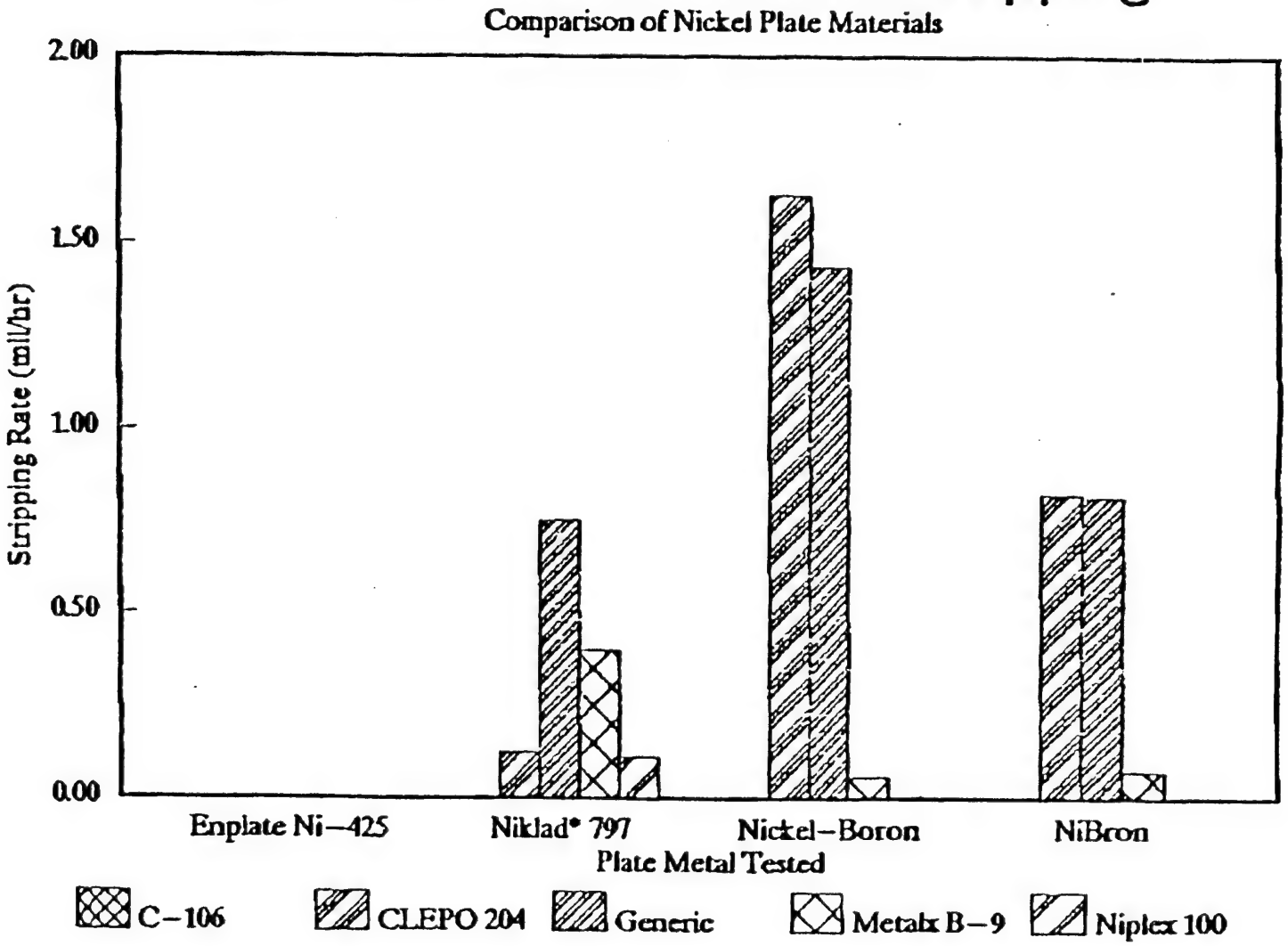
4. We recommend the use of Niklad 797 coating if it meets all the metallurgical requirements for aircraft engine parts applications. The use of this coating as opposed to the use of a high phosphorous electroless nickel coating will allow implementation without refurbishment problems. Presently there are no known immersion non-acid strippers that will remove high phosphorous nickel coatings.

Kurt W. Greebon

Kurt W. Greebon/Chemist
Chemical Processes Laboratory

Ray Martinez, Chemist
EG&G Idaho, Inc.

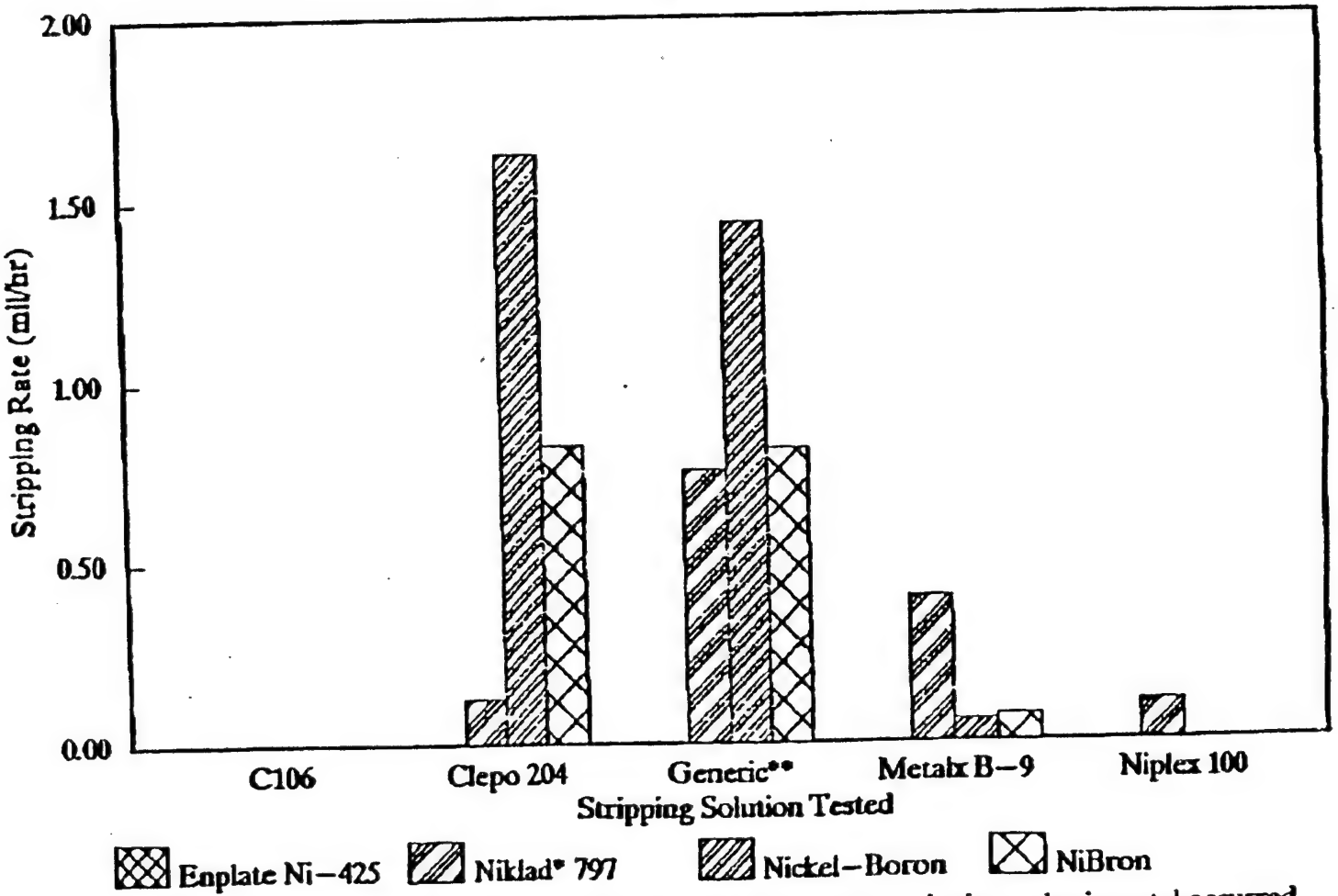
Alternative Plate Material Stripping



ATCH. # 1

Nickel Plate Material Stripping

Comparison of Numerous Strippers



** Nickel–Boron stripping rate is higher than shown since complete stripping to basis metal occurred.

ATCH. #2

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SAN ANTONIO AIR LOGISTICS CENTER (AFLC)
KELLY AIR FORCE BASE, TEXAS 78241-5000

REPLY TO ATTN OF: Kurt Greebon (LPPTAH) & Ray Martinez (EG&G Idaho, Inc.)

SUBJECT: Implementation of Non-Cyanide Strippers

TO: Jesse L. Herrera/LPPTA
Gary Herrin/LPPTAH

The results to be discussed in this report were obtained from the implementation of two non-cyanide metal strippers at the plating shop (Bldg 301) at SA/ALC, Kelly AFB in San Antonio, Texas. Implementation of these strippers meets some of the goals established in the Non-Cyanide Metal Stripper Replacement Program contract. These accomplishments should help the Air Force meet their goal of making their metals plating/refurbishment shops safer for the workers through utilization of safer chemicals.

One of the non-cyanide metal strippers implemented was B-9 nickel stripper which is manufactured by Metalx, Inc. This stripper is recommended by the manufacturer for stripping nickel coatings from steel base metal parts and was implemented at the plating shop on May 6, 1991. This stripper was selected for implementation due to its excellent basis metals protection, good stripping rate for nickel coatings, and rinsing properties. Based on the field optimization test data, this stripper was the best available stripper which would meet the requirements established by the KAFB Plating Shop management. This stripper will remove both the sulfamate (electrolytic) and phosphorus (electroless) nickel coatings at an acceptable production rate in the temperature range of 140°±5°F and meets the basis metals protection, personal safety and rinsing requirements. During the implementation period 06 May - 06 Sept 1991, 566 aircraft parts were evaluated. These parts represented a cross section of parts from three different A/C engines and other aircraft parts which are currently processed at the plating shop. A list of these parts is cited below. All aircraft parts used to evaluate this stripper showed good basis metals protection and satisfactory nickel stripping rates. Most of these parts stripped completely in a time period of four to eight hours. The exception to this time period occurred only whenever the solution stripping rate deteriorated to a level that required more than one work shift to complete the stripping process on some parts. Other conditions such as heavy buildup nickel and nickel base metallized coatings also required more than one shift to completely strip the parts. The stripper solution pH values were very stable and did not vary more than 0.3 pH unit during the evaluation. The only corrosion problems experienced occurred on one twenty four hour basis metals control test where the C4340 and D6AC, low alloy steel, test coupons developed signs of corrosion and significant weight loss. Two other basis metals which showed a small effect were the Haynes 188 and the 17-4PH, high alloy coupons. These corrosion effects are illustrated by the

forty day results on the Metalx B-9 Implementation Basis Metals Protection graph presentation in attachment No.1 of this report. On this particular control test the strip tank was heavily loaded with engine parts and as a result the basis metals coupons were in direct contact with the engine parts. This conclusion is the only explanation for the above mentioned corrosion effects problem and is based on the abnormal smut residue found on the surfaces of the C-4340 and the D6AC test coupons. This smut residue is common on most nickel coated parts while they are being stripped.

Aircraft parts Evaluated:

F-100 A/C Engine Parts:

- Bracket assy., bleed valve----- 84
- Plate assy.---------- 25
- Nuts, brg. retainer---------- 27
- Bushing assy.---------- 19

T-56 A/C Engine Parts:

- Compressor Wheels---------- 66
- Tie Bolts---------- 25
- Bolts, shear---------- 7
- Shaft, prop.---------- 34
- Seals, Labyrinth---------- 8

TF-39 A/C Engine Parts:

- Bolts, coupling---------- 20
- Nuts, coupling---------- 15
- Turbine Wheels---------- 15
- Thrust Bearings, Lock prop.---- 22

GT Engine Parts:

- Breech Caps---------- 17
- Turbine Wheels---------- 76

B-52 Aircraft Parts:

- Engine mount---------- 12
- Bolt cones---------- 17

Lock Pins---------- 10

Supports---------- 14

Brackets---------- 39

C-5 Aircraft Parts:

Brackets---------- 14

The implementation testing followed the addition method as outlined in the technical bulletin provided by Metalx, Inc. This method of stripper utilization was selected to prolong the solution bath life due to the continuous twenty-four type of stripping operation which is used at the plating shop. Unfortunately, during the first month of this implementation, the initial make-up bath experienced several over-heating conditions as a result of the shop air compressor failures. These air compressor failures produced over-heating of the stripper solution due to lack of air agitation. These over-heating conditions resulted in premature deterioration of the solution and subsequent poor stripper stability. The stripping rates for both nickel coatings started at reasonably high rates, then the strip rates started to fall dramatically. After the fourth week of operation, a regeneration addition of the stripper was required. This addition provided regeneration to an acceptable rate, however, the enchanced stripping rate did not last for more than a week. The next addition also dramatically improved the stripping rate, but it appears that the stripping rate also falls rather fast after one week's use. This pattern of addition then loss of stripper efficiency continued for almost two months. Each time a new addition was made, the bath regenerated just slightly less than it had for the previous addition. For a graphical presentation of these strip rate results refer to attachment No. 2. By extrapolating the decline in stripping rate, it was estimated that the bath would last between 4 to 5 months before disposal would be required.
Discussion of this implementation results with the stripper manufacturer of this product led to an offer by him to supply 1250 pounds of the stripper at no cost to EG&G Idaho, Inc. or the Air Force for retesting purposes.
Discussions with the plating shop laboratory personnel, Gary Herrin and Kurt Greebon, and Mark Argyle of EG&G led to the decision to retest this product. This retesting decision was agreed to in the interest of making a fair evaluation of this product under proper shop operating conditions. Since a few weeks remained budgeted to complete this implementation evaluation, Mr Gary Herrin, the acting laboratory supervisor agreed that his laboratory personnel would complete the evaluation of this stripper. The new make-up batch was prepared on August 10, 1991 and fortunately, no overheating conditions have been experienced through the sixth week of operation.
The new batch stripping rates for both the phosphorous and sulfamate nickel coatings have remained very stable and the basis metals protection have been satisfactory. These control test results are included in attachments No.3 and No. 4 of this report. No solution odor or emission problems were encountered during the evaluation period. The present push/pull ventilation system handled the production use of this stripper well enough to contain whatever solution vapors are emitted without any problems. Based on the test results for the 2nd batch, the 1st regeneration will be necessary in the 7th or 8th week.

Based on the implementation evaluation results, Metalx B-9 Nickel Stripper can be used in lieu of the T.O. 42C2-1-7, Table 13-1, step 3, cyanide base nickel stripper, (C-106 stripper) applications requiring the stripping of electroless nickel coating from steel base metal parts at the temperature range of 140°±5° F. An AFTO Form 22 has been prepared and is included as attachment No. 7, for use to make the required T.O. 42C2-1-7 change. The benefits that the Air Force can realize by the use of B-9 nickel stripper are improved worker safety, less waste generation because of it's superior stability over cyanide type stripper, and better stripping production.

The McGean-Rohco, Inc. Electrolytic Rostrip* 999-SP Stripper was implemented to strip silver coatings at the SA/ALC Plating Shop on June 14, 1991. During the implementation period, 14 Jun - 14 Sept, 1991, a total of one hundred and forty four aircraft engine parts were evaluated. These parts represented cross section of those that are currently stripped in this production application and are listed below. The Rostrip* Stripper was evaluated with respect to strip rate, basis metals protection, rinsing and fume properties in a production environment. All aircraft parts used for this stripper evaluation were successfully stripped and no corrosion problems were experienced. With a few exceptions, all parts were stripped in a time period of 15 to 30 minutes. Some parts did require additional rinsing as opposed to what is required when the cyanide silver stripper is used. No odor or vapor problems were encountered during the evaluation of this stripper. Basis metals protection and stripping rate control tests were also performed to correlate the results of the A/C parts with the test coupons. The implementation of this stripper has yielded mixed results. This stripper was not originally formulated as a silver stripper and the implementation control coupon tests results verified this fact. The field test results from last year indicated that this stripper would work well for stripping silver from low alloy and stainless steel parts. The problem arises when other metal alloys are used. High alloys such as Haynes 188 and Inconel 718 showed severe etching when used in this stripper. The solution does not remain clear and quickly develops a grayish colored sludge which interferes in the inspection of the parts during stripping while agitating the solution. Since the stripping rate is not enhanced by agitation of the solution this inspection problem can be reduced by eliminating the agitation. Despite these problems, the silver stripping rate is excellent at all pH levels tested and at ambient temperatures. A comparison of strip rate and basis metals protection between the cyanide and Rostrip* 999-SP Silver Strippers are illustrated on graph attachments No.5 and No.6.

Implementation A/C Parts Evaluated:

TF-39 Engine Parts:

Nuts, spanner----------10

Nuts, split----------09

Nuts, Coupling----------12

Seals, Labyrinth----------10

Tubes, adaptors LPT & HPT---26

Bolts, Coupling FAN, HPT----04

Bolts, Coupling Fan, LPT----04

Adaptor, HPT Rotor----------02

T-56 Engine Parts

Shaft, Prop----------12

Gear, Sun----------08

Gear, Spur----------06

Hub, Sun Gear----------02

Hub Flange, Sun Gear--------02

Shaft Assy, Alter Drive-----03

Shaft Assy, Hyd. Pump Drive-03

Sleeve, Oil Inlet----------08

F-100 Engine Parts:

Nuts, Bearing----------03

Idler Gears----------10

C-5 Aircraft Parts:

Bushings----------10

Based on information obtained from the plating shop laboratory acting supervisor (Mr. Gary Herrin) concerning Silver Stripping Processes, changes were made to control the silver recovery. These changes consist of eliminating the use of the large nitric acid tank solutions and instead using a small tank solution of nitric acid to strip silver off all stainless steel and other high alloy steel parts only. These silver stripping process changes should support the full production implementation of this non-cyanide silver stripper for use in lieu of the presently used cyanide stripper. Based on this implementation evaluation results the use of this stripper must be in conjunction with the use of nitric acid stripper for stripping high alloy metals such as the Haynes 188 and Inconel 718 types of metals. The low-alloy steel parts which cannot be stripped in acidic solutions can be stripped in the Rostrip* stripper. At this time, there are no known non-cyanide immersion strippers capable of removing silver coating other than nitric acid type strippers. Based on these evaluation results, the McGean-Rohco Electrolytic Stripper Rostrip* 999 SP can be used as cited above in lieu of Air Force

stripper T.O. 42C2-1-7, Table 16-1, C-101, cyanide stripper. An AFTO Form 22 has been prepared and is included as an attachment No.8, for submission to make the required T.O. 42C2-1-7 change. The benefits that can be realized by the Air Force by use of this silver stripper are worker safety (less hazardous stripper from the stand point of the elimination of the toxic cyanide) and less costly waste generation because the Rostrip* can be regenerated and is considerably less costly to dispose. NOTE: *Rostrip is a registered trade name of McGean-Rohco, Inc.

Based on the experience gained by the 1990 and 1991 implementation of noncyanide nickel strippers (Clepo 204 and Metalx B-9) a considerable reduction in waste generation has been accomplished. This waste generation reduction is equivalent to approximately 73% and is based on the following stripper utilization as compared to Environmental Management Office reported cyanide stripper waste of 20,558 gal in 1989.

The maximum volume of the noncyanide electroless nickel stripper (Metalx B-9 or Ni-plex 100) required for one year operation is 5,000 gal.

The maximum volume of the noncyanide electrolytic nickel stripper (Clepo 204) required for one year operation is 660 gals.

The reduction in nickel stripper waste is equal to:

20,558 gals (cn stripper waste) - 5,660 gals.
(noncyanide waste) = 14,989 gal (waste reduction)

The annual savings will be:
14,898 gal X $2.59 (Waste Treatment cost per gal) = $38,585.82

$$\% \text{ Waste reduction} = 100 - \frac{5{,}660 \text{ gal noncyanide waste}}{20{,}558 \text{ gal noncyanide waste}} \times 100 = 72.5$$

This noncyanide waste can further be reduced by the utilization of a smaller size tank of 1000 to 1200 gallons for the electroless nickel stripping process. The use of a 1000 gal size tank can reduce this waste total volume to 2,660 gal or if the 1200 gal tank is used, the total waste would be 3,060 gallons.

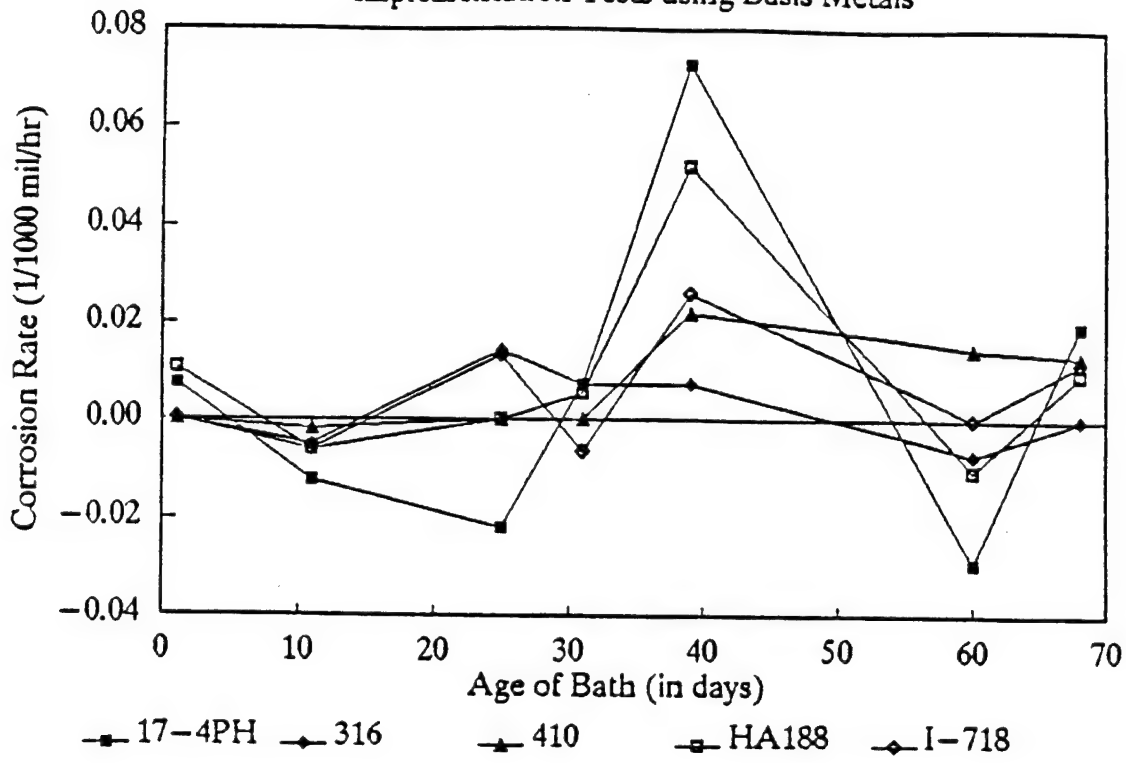
Kurt W. Greebon
KURT W. GREEBON
CHEMIST

Ray Martinez
RAY MARTINEZ
EG&G IDAHO, INC.

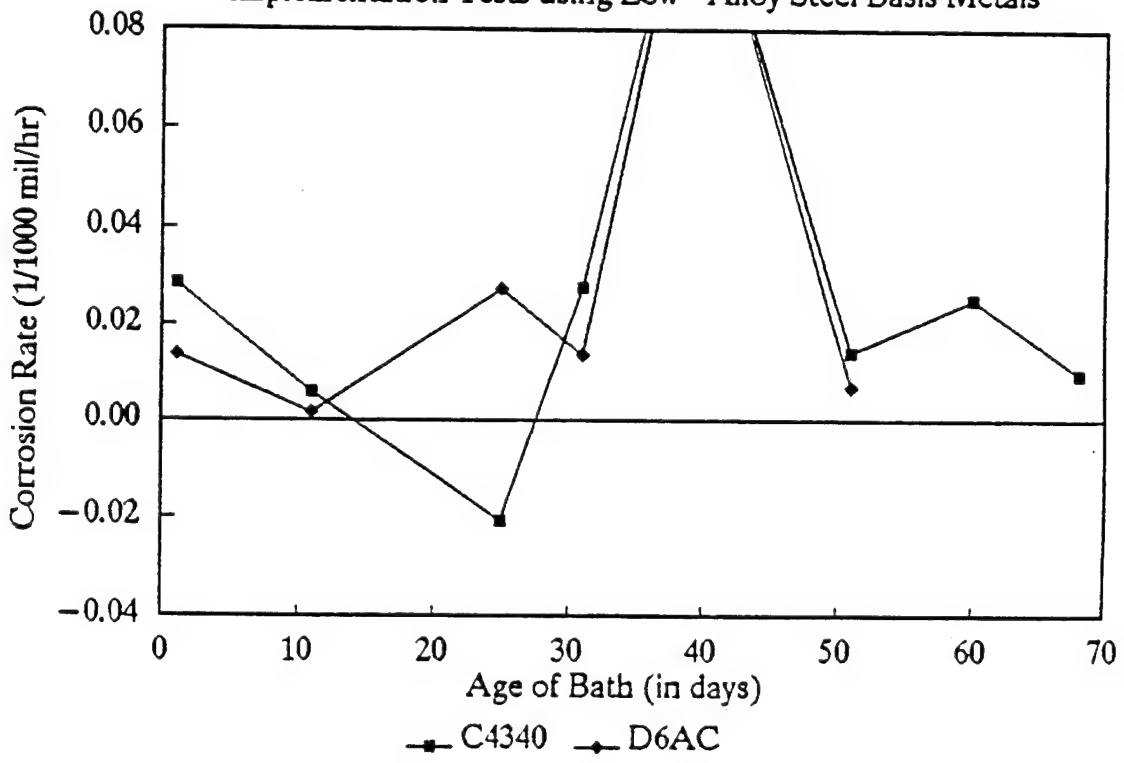
cc: KAREN SOLARI

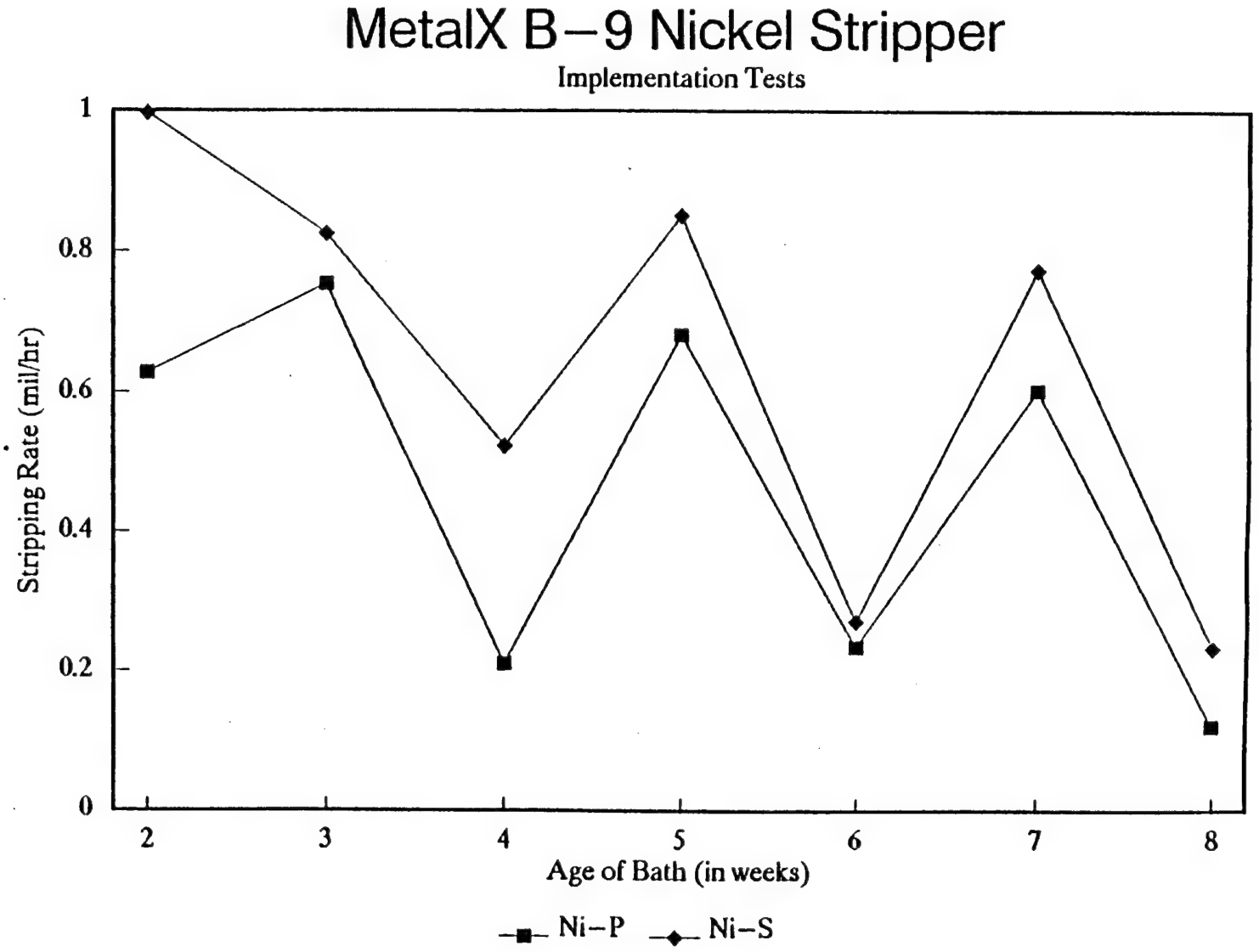
Metalx Inc.'s B–9 Nickel Stripper

Implementation Tests using Basis Metals

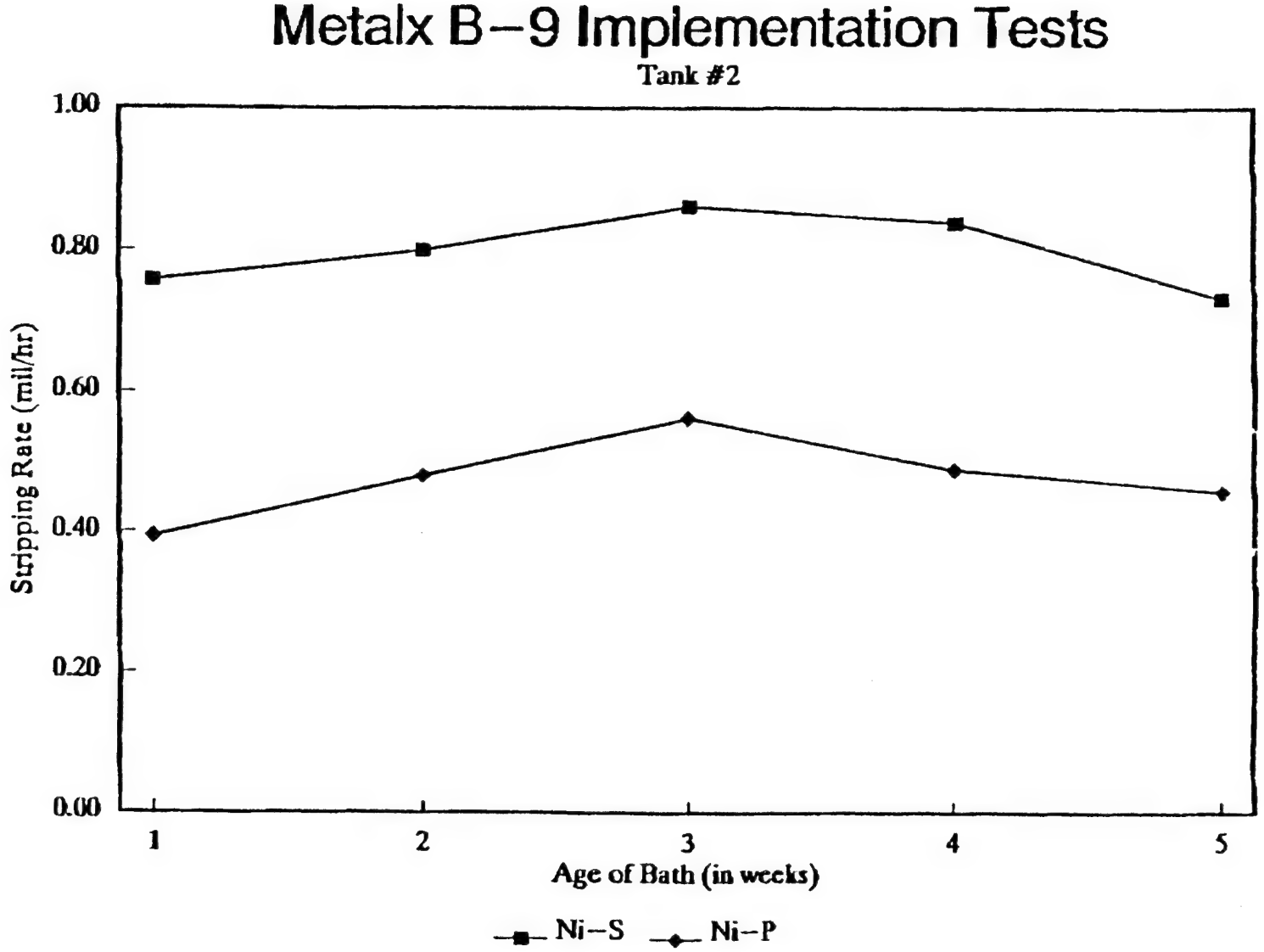


Implementation Tests using Low–Alloy Steel Basis Metals





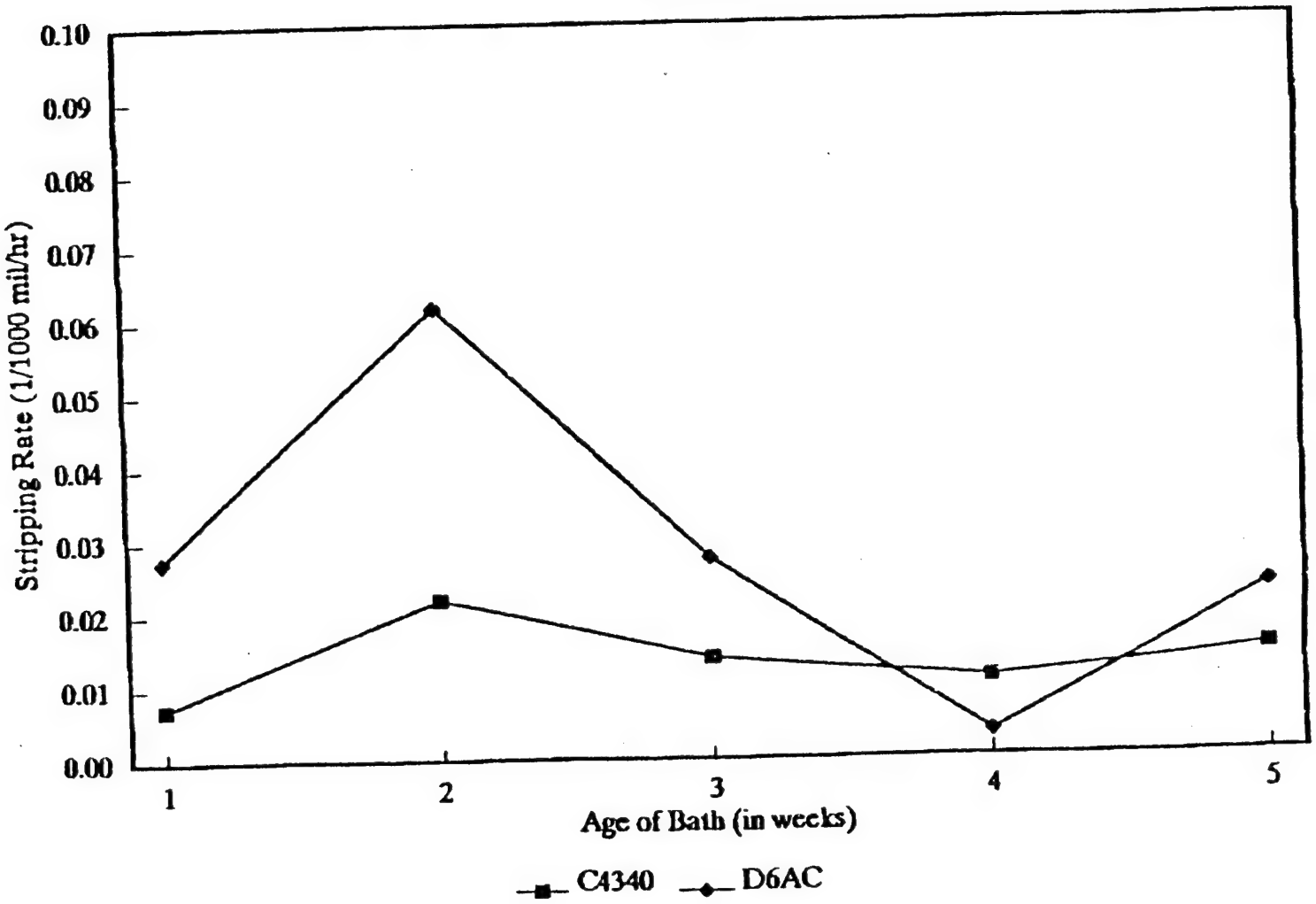
Attachment No. 2



Attachment No. 3

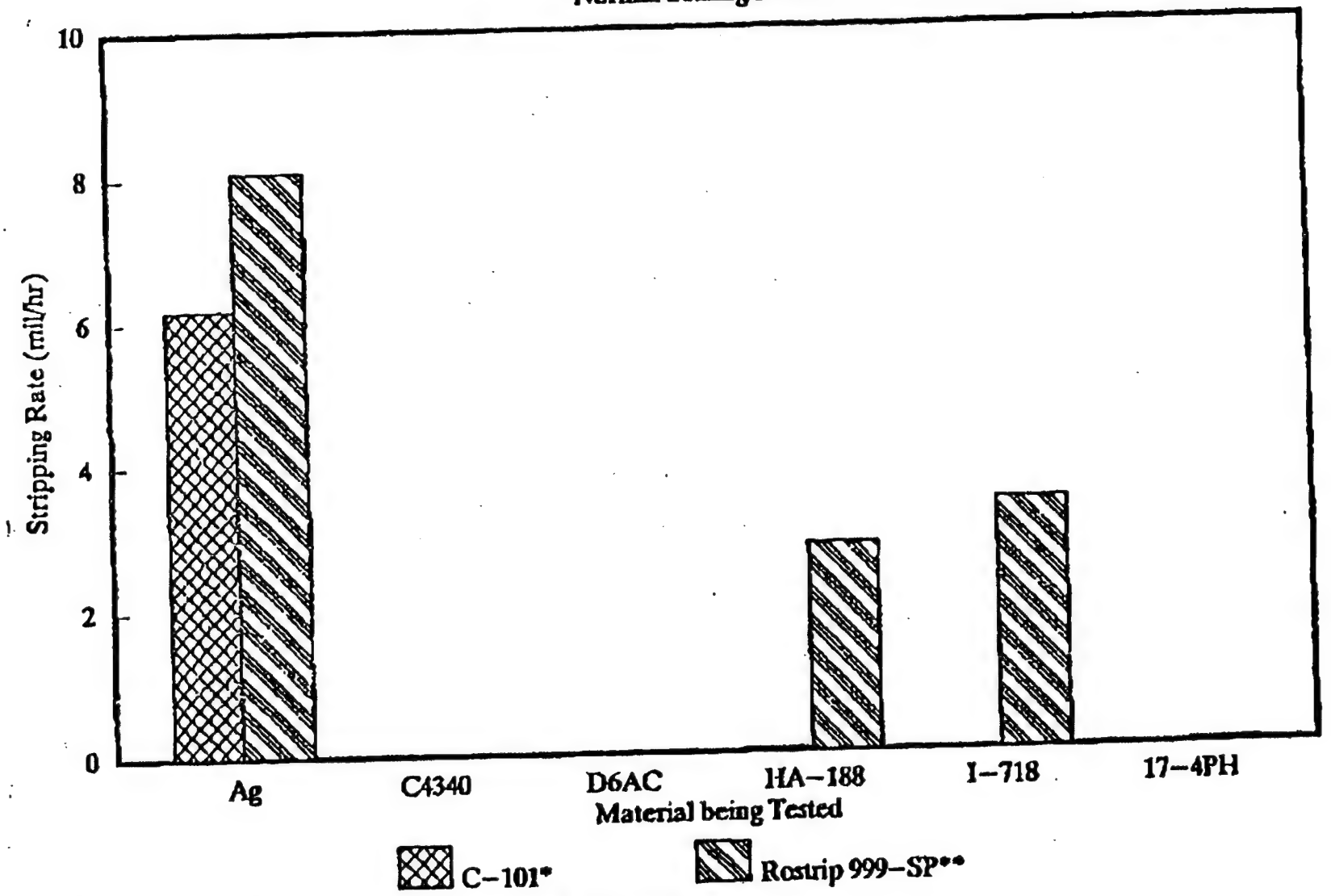
Metalx B-9 Implementation Tests

Tank #2



Attachment No. 4

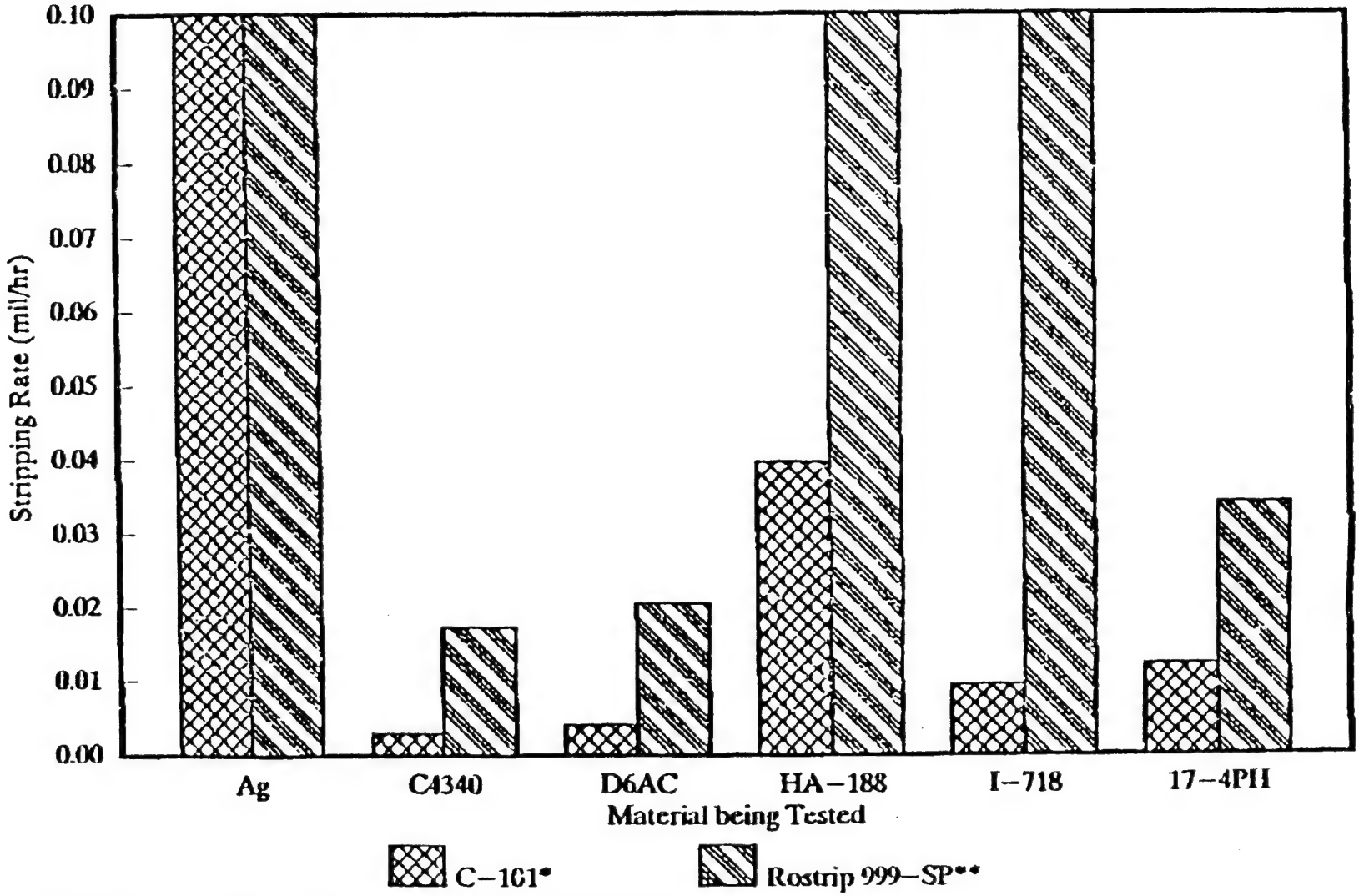
Comparison Stripping of Rostrip 999-SP with AFB C-101 Process
Normal Scaling Factor



* Conditions: ambient temp., pH 13.0, 4.0 Volt, 6.0 Amp
** Conditions: ambient temp., pH 12.0, 3.8 Volt, 6.0 Amp

Attachment No. 5

Comparison Stripping of Rostrip 999–SP with AFB C–101 Process
Scaling to Enhance Baseline Values



* Conditions: ambient temp., pH 13.0, 4.0 Volt, 6.0 Amp

**Conditions: ambient temp., pH 12.0, 3.8 Volt, 6.0 Amp

Attachment No. 6

TECHNICAL ORDER SYSTEM PUBLICATION IMPROVEMENT REPORT AND REPLY

FORM APPROVED OMB NO. 21-R0207

1. TO: (Major Command or equivalent)	2. TO: (Orgn having Mgmt Responsibility for the T.O.)	3. FROM (Orgn reporting)	4. REPORT DATE (YR MO DAY)
SA-ALC	TIRTR/SFTT	LPPTAH	91 09 30

5. BASIC DATE OF T.O.	6. DATE OF T.O. CHANGE	7. PAGE NUMBER	8. PARAGRAPH NUMBER	9. FIGURE NUMBER
15 MAR 79	1 SEPT 89	13-3	13-7	TABLE 13-1, Step 3

DOC IDENT	TO	FROM	TECHNICAL ORDER NUMBER	IMPROVEMENT REPORT NUMBER
XYA	H		42C2-1-7	

10. BRIEF SUMMARY OF DEFICIENCY AND RECOMMENDED CHANGE (Use continuation sheets if necessary)

Deficiency:

The currently cited stripper solution, C-106, for removing electroless nickel coatings contains sodium cyanide, from 10 to 14 oz. per gallon, as one of the formulation ingredients. The stripper, because it contains sodium cyanide, is toxic and if accidently mixed with an acid will produce highly toxic hydrocyanic acid. In addition, large volumes of waste are generated because it has a short service life. This waste is difficult to treat by industrial waste treatment facilities and at times disposal by contractor is the only alternative.

Recommended Change:

Recommend that nickel cyanide stripper, C-106, cited in Step No. 3 of Table 13-1 be replaced by Metalx B-9. A non-cyanide nickel stripper, that has a superior stripping rate, a longer service life and is safer to use. This stripper has been tested by EG&G Idaho, Inc. on an Air Force contract and found to be satisfactory for this application.

(Continued)

11. REPORTED BY (Initiator's Signature, OAS and Extension)	12. APPROVED BY (Supervisor's Signature)	13. QUALITY CONTROL (Signature)

14. MAJOR COMMAND ACTION	15. (Check applicable block) ☐ APPROVED ☐ DISAPPROVED	16. SIGNATURE (Major Command Authority)	17. DATE

☐ TR CODE: DAA | DATE RECEIVED (YR MO DAY) | DATE TO MGR (YR MO DAY) | MGR | TRANSFER CODE | DOWNGRADED | (Reserved)

☐ TR CODE: DBA | DATE FROM MGR (YR MO DAY) | ACTION TAKEN | RESOLUTION DATE (YR MO DAY) | (Reserved)

18. TO: (Major Command or equivalent)	19. TO: (Organization Reporting Improvement)	20. FROM (SM/IM)

21. REMARKS Use continuation sheets if necessary)

22. DATE OF REPLY	23. REPLY BY (Signature, OAS, Extension)	24. APPROVED BY (Supervisor)

AFTO FORM 22 APR 73

ATCH #7

REPLACES AFTO FORMS 22 AND 22A WHICH ARE OBSOLETE

Continuation Sheet:
Metalx B-9 and Ni-plex 100 Nickel Strippers:

Recommendation: (Continued)

Also recommended to be included as an alternate stripper for this application is Ni-Plex 100 nickel stripper. This product was also tested in a field optimization study and found to be satisfactory.

These products are manufactured by the following companies:

Metalx B-9 Nickel Stripper
Metalx, Inc.
RT., Box 683
Lenoir, NC 28645
Phone: Toll Free 1-800-752-7649

Ni-plex 100 Stripper
M&T Chemicals, Inc.
Rathway, New Jersey
07065-0970
Phone: (201) 499-0200

Operating Conditions:

Stripper concentration - These one component strippers can be used in either a Batch Method at 2.5 pounds per gallon or by an Addition Method at 1.5 pounds per gallon. We recommend the use of the addition method for continuous shift operations.

Operating Temperature Range ------ 120° - 150°F

Operating pH range, Metalx B-9 ----- 9.5 - 10.5
Ni-plex 100 ---- 8.5 - 10.5

Method of Agitation - Mechanical Impeller, Air (gentle) or pump circulation.

Solution Preparation:

1. Add water to a 50% level of the operating tank volume.

2. Heat solution to 120°F.

3. Add the required amount (1.5 or 2.5 pounds) of stripper compound.

4. Add water to the required operating volume level.

5. Start agitation system and allow compound to completely dissolve.

6. Determine pH of the solution and if below the range, adjust pH value to the required range with small additions of soda ash.

NOTE: If production flow allows, turn off heat when solution is not being used.

For additional information refer to product bulletins.

TECHNICAL ORDER SYSTEM PUBLICATION IMPROVEMENT REPORT AND REPLY

FORM APPROVED OMB NO. 21-R0207

1. TO: (Major Command or equivalent)	2. TO: (Orgn having Mgmt Responsibility for the T.O.)	3. FROM (Orgn reporting)	4. REPORT DATE (YR MO DAY)
SA-ALC	TIRTR/SFTT	LPPTAH	91 09 30

5. BASIC DATE OF T.O.	6. DATE OF T.O. CHANGE	7. PAGE NUMBER	8. PARAGRAPH NUMBER	9. FIGURE NUMBER
15 MAR 79	1 SEPT 89	16-5	16-7	TABLE 16-1, Step 3

DOC IDENT	TO	FROM	TECHNICAL ORDER NUMBER	IMPROVEMENT REPORT NUMBER
XYA	H	42C2	-1-7	

10. BRIEF SUMMARY OF DEFICIENCY AND RECOMMENDED CHANGE (Use continuation sheets if necessary)

Deficiency:

The currently cited stripper solutions, C-101 and C-106, for removing silver coatings contain sodium cyanide, from 10 to 14 oz. per gallon, as one of the formulation ingredients. These strippers, because they contain sodium cyanide are toxic and if accidently mixed with an acid will produce highly toxic hydrocyanic acid. In addition, the volumes of toxic waste generated are very costly to treat. This waste is difficult to treat by industrial waste treatment facilities and must be disposed of by contractor.

Recommended change:

Recommend that the silver cyanide base strippers, C-101 and C-106, cited in Step No. 3 of Table 16-1 be replaced by Rostrip* Electrolytic Stripper 999-SP. A non-cyanide silver stripper, that has a superior stripping rate and is environmentally safe to use. This stripper has been tested by EG&G Idaho, Inc. on an Air Force contract and found to be satisfactory for this application.

(Continued)

11. REPORTED BY (Initiator's Signature, OAS and Extension)	12. APPROVED BY (Supervisor's Signature)	13. QUALITY CONTROL (Signature)

14. MAJOR COMMAND ACTION	15. (Check applicable block) ☐ APPROVED ☐ DISAPPROVED	16. SIGNATURE (Major Command Authority)	17. DATE

☐ TR CODE (46 47 48) DATE RECEIVED (YR 49 50, MO 51 52, DAY 53 54) DATE TO MGR (YR 55 56, MO 57 58, DAY 59 60) MGR (61) TRANSFER CODE (62 63 64 65 66) DOWNGRADED (67) (Reserved) (68 69 70 71 72 73 74 75 76 77 78 79 80)

D A A

☐ TR CODE (46 47 48) DATE FROM MGR (YR 49 50, MO 51 52, DAY 53 54) ACTION TAKEN (55 56 57 58 59 60 61 62 63 64 65 66) RESOLUTION DATE (YR 67 68, MO 69 70, DAY 71 72) (Reserved) (73 74 75 76 77 78 79 80)

D B A

18. TO: (Major Command or equivalent)	19. TO: (Organization Reporting Improvement)	20. FROM (SM/IM)

21. REMARKS (Use continuation sheets if necessary)

22. DATE OF REPLY	23. REPLY BY (Signature, OAS, Extension)	24. APPROVED BY (Supervisor)

AFTO FORM APR 73 22 ATCH. #8 REPLACES AFTO FORMS 22 AND 22A WHICH ARE OBSOLETE

Rostrip* Electrolytic Stripper 999-SP is manufactured by McGean-Rohco, Inc. 1250 Terminal Tower, Cleveland, Ohio 44113, (216) 621-6425.

Operating Conditions:

1. 1-2 pounds per gallon of water.
2. pH range 10-12.
3. Use stainless steel cathodes.
4. Ambient operating temperature.
5. 50 ASF Maximum current density.
6. 0-10 volts rectifier.
7. Reverse current (part is anode).

NOTE: For additonal operating requirements refer to product data bulletin.

*Rostrip is a registered trade mark.